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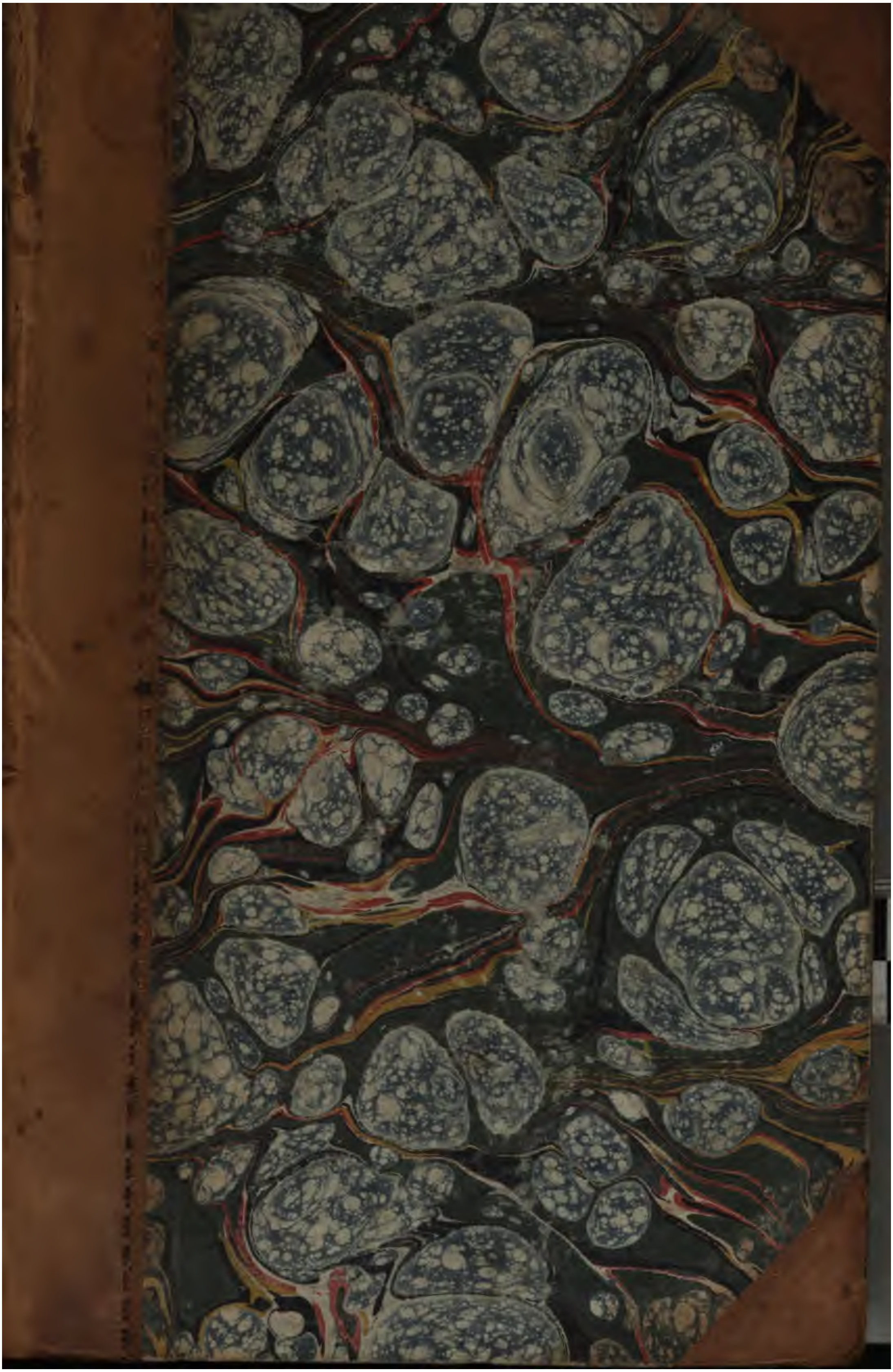

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GILL'S

TECHNOLOGICAL REPOSITORY;

OR,

DISCOVERIES AND IMPROVEMENTS

IN THE

Useful Arts,

BEING A CONTINUATION OF HIS TECHNICAL REPOSITORY.

By THOMAS GILL, *Patent-Agent*,

AND DEMONSTRATOR IN TECHNOLOGY, ON THE APPLICATION OF SCIENCE TO THE USEFUL ARTS AND MANUFACTURES;

UPWARDS OF TWENTY YEARS A CHAIRMAN OF THE COMMITTEE OF MECHANICS IN THE SOCIETY FOR THE ENCOURAGEMENT OF ARTS, MANUFACTURES, AND COMMERCE, ADELPHI, LONDON;

HONORARY MEMBER OF THE ROYAL PRUSSIAN ECONOMICAL SOCIETY OF POTSDAM; AND A CORRESPONDING MEMBER OF THE ROYAL BAVARIAN POLYTECHNICAL AND AGRICULTURAL SOCIETIES OF MUNICH.

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GILL'S

TECHNOLOGICAL REPOSITORY.

I.—*On splitting, cutting, and polishing Diamonds; and on forming, mounting, and using Engravers, Glaziers, and Writing Diamonds, Diamond Dust, &c.* By Mr. EDMUND TURRELL, *Engraver.*

WITH A PLATE.

DEAR SIR, *46, Clarendon-street, Somers-town, June* 10, 1827.

I MENTIONED to you, several years since, my intention of giving you for insertion in your valuable work, an article on the above interesting subjects; being chiefly the substance of memorandums I had taken some years ago, when I was afforded a favourable opportunity of witnessing the actual performance of several of the processes, by some Jews, who follow the profession of diamond cutting. I had, however, as I then informed you, lent those memorandums to Bryan Donkin, Esq., the celebrated engineer; and he, on his removal from his former residence to his present one, in the hurry and confusion incidental to such removal, having mislaid them, it was only lately that he happened to find and restore them to me.

I have, at the request of several respectable members of the Royal Institution, had the honour of reading this article on one of the Friday evening conversationes, held in that valuable institution; and I likewise more recently repeated it, at the meeting of the Society of Civil Engineers; and the high and marked approbation it received in both instances, convinces me that it contains much useful information on these interesting subjects, which is well worthy of being more widely diffused, through the medium of your *Repository.*

I now, therefore, present to your, and your readers, notice, a few observations upon the application of the diamond and other precious stones, to some of the arts and manufactures, that are successively practised in this country.

I must, however, previously intreat your indulgence to those imperfections, which must necessarily attend any endeavour on my part to describe the details of subjects, which I do not profess to practise.

If many of the arts that are practised in this country could be readily seen and investigated by the public, there would be no occasion for my directing your attention to the subjects I am about to offer to your notice; but, as many really meritorious individuals are for years together employed in their lonely attics upon the most ingenious pursuits, and entirely unknown to any but their constant employers, so it must necessarily follow, that their modes of operating, and all the curious *technicalities* of their various arts, are hidden from the public, and known only to those professing, or connected with their arts.

The Rev. Dr. William Pearson, F. R. S., in one of his articles in "Rees's Encyclopedia," states, that "if you would investigate the means by which the beautiful specimens of clock and watch-work are produced in this country; you must consent to enter the most obscure courts and alleys, where, having mounted to the attic regions, you will there find the illiterate inmates ingeniously pursuing their daily avocations, unknown to the public, and often completely unacquainted with the scientific principles that are so intimately connected with their pursuits."

I however trust, that the efforts which have already been made, and are still making, to diffuse and inculcate scientific information, amongst the class of persons I have just alluded to, will soon have the effect of removing such a stigma, and render such remarks obsolete.

These circumstances, therefore, have induced me to offer to your notice a few facts relative to the methods employed, to *split*, *cut*, and *polish* the diamond; as well also, as its applications in some of those useful and ingenious arts which add to our pleasures and relieve our necessities.

The diamond is, of all substances, the hardest we are acquainted with. It can only be cut or fashioned into any required form by *abrasion*, which is performed by forcibly rubbing the surface of one diamond against that of another. The diamond is found both in rolled or rounded pieces, and also crystallized. Its primitive figure is the octahedron, in which each plane is inclined to its adjacent one, at an angle of 109° or thereabouts; the facets are usually curvilinear, whatever the form of the crystal may be; but, as I shall have occasion to show that the octahedron is the form which is most usefully applied to the arts, and as a correct description of its various other modifications in respect to crystallization is foreign to my intention, I shall not make any further observations on that head.

On splitting Diamonds.—Although the diamond is excessively hard, yet it may be separated into various pieces by *splitting*, which is performed by substances much softer than itself; but to effect this purpose, a blow is necessary to be given. As splitting is generally employed for one or two different purposes, I will endeavour to explain the intent of each. It is always an object of the greatest importance, when diamonds are to be cut and polished for ornamental purposes, to choose that part of the stone for the table or front, which will afford the greatest breadth; but, as some stones present so much of a spherical form, it is desirable to remove certain portions thereof by the operation of splitting, which saves the great labour of reducing or removing such portions by cutting or abrasion; and it has also the farther advantage of sometimes producing pieces, which may be cut and polished, so as to form smaller stones. The other case where splitting is necessary, is, when a stone of considerable size is so formed, that it will split into several pieces, each sufficiently large to make a valuable stone when polished, and thus be more profitable, than if it had been worked as a single stone. This proceeding is not, however, very often resorted to, because diamonds increase so greatly in value as their size increases. When a stone is nevertheless to be broken, for the reasons just stated, it is usually separated into six pieces, the peculiar cleavage of the diamond being favourable to such a division.

When a diamond is to have a part removed or separated from it by splitting, which is a process that requires a thorough knowledge of the subject, it is fixed into a ball of cement, about the size of a walnut, the cement being warmed previously; the stone is then imbedded partly in it, taking care to leave that part uncovered which it is determined to separate. Another whole diamond, having a sharp edge, or a piece that has been split from some other stone, is then fixed in another ball of cement, letting the part which has the sharp edge protrude; and with this edge a slight gap or notch is made on the stone to be split, by a kind of sawing movement, until a groove is formed sufficiently deep to receive the extreme edge of a blunt razor blade, which being smartly struck by a hammer, while the stone is held in a favourable position, the intended piece may then be removed with considerable facility, by a person practised in the method.

The cement used for this purpose is brought from Holland, where it is probable diamond cutting and polishing were first performed in Europe. Its appearance is like the common cement formed of resin, pitch, and very fine brick dust; but it is very much tougher, and more adhesive.

Where more than one piece is to be split from a stone, the same methods of fixing, notching, and splitting, must be repeated; and then the stone is considered to be in a fit state for *cutting*.

It will now be evident that the diamond, although infinitely harder than steel, may yet be broken with ease by that metal, if it be acted upon by a blow properly applied.

On cutting Diamonds.—The next operation is, to give a proper form to the facets or faces (which, it must be observed, are always planes); and for that purpose, the stone must be imbedded in cement, fixed on the end of a small stick of wood; that part of the diamond being allowed to protrude out of the cement, upon which it is intended to form a principal plane, or facet.

If a diamond cutter has only a single stone to cut, he must then provide himself either with another whole stone or a piece of one; and which must also be fixed on a similar handle or stick, by means of cement; a part of the piece or whole stone being left to project, in order that it may be used to rub or abrade the surface of the stone to be cut. But it rarely happens that this circumstance, of having one stone to cut, is necessary to be resorted to; as it will be easily conceived that a great loss of time and labour takes place in such a mode of proceeding, as two stones may be cut in the same time as one only; the abrasion being generally equal, and similar on each.

When the two stones are affixed to the handles, as I have described, the diamond-cutter seats himself in front of his work-board, upon which, is affixed a small, strong, mahogany box, about four inches long, three inches wide, and three inches deep. The sides of the box are half an inch in thickness, which gives it considerable strength. The upper surfaces of the four sides of the box are each covered by a rim of steel, and in the centre of each of the longest sides, a perpendicular pin of steel is firmly affixed, which pins are used as fulcra, against which the handles or sticks, holding the stones, are to be firmly pressed when in operation.

The two stones are now to be pressed with very considerable force against each other, and at the same time the sticks being also pressed firmly against the steel pins on the two edges of the box, a rocking motion is to be given to each stick in opposite directions; the steel pins being, as above mentioned, the fulcra, or centres of motion of the sticks.

By thus rubbing the two stones against each other, the convex surfaces that are brought into contact are reduced by the continued abrasion, until they assume a roughly flat surface, or principal facet.

As that part or end of each handle that contains the diamond, or to which it is affixed by the cement, extends only about an inch or an inch and a half beyond its bearing against the steel pin, on the side of the box, it will be easily conceived, that it can only describe the arc of a circle of that radius. But the other portion of the handle, or stick, which is grasped by the hand of the workman, being much longer, it enables the operator to use it with great power, on account of its greater leverage, and which, of course, enables him to exert a very great force, that being absolutely necessary.

The mahogany box, has also a small thin plate of brass made to fit it very exactly; which, being pierced with a great number of fine holes, acts as a sieve, to let the very fine, and nearly impalpable powder pass through, which is formed by the abrasion of the diamonds against each other. The box is also furnished with a lid or cover, which the workman most carefully puts upon the box every time that he examines the facet he is producing.

This fine dust, is technically called "*diamond powder,*" in order to distinguish it from a somewhat similar powder, which is produced by bruising the diamond in a hardened steel mortar, with a steel pestle; by which means the diamond may be separated into very fine particles and become exceedingly useful for certain purposes, which I shall explain hereafter*.

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* See the description of the common steel mortars and pestles used for this purpose, and also of improved ones, with engravings of both sorts, in our *Technical Repository*, Vol. VII. p. 52.

The mode of examining the facets of the diamond, while under the process of cutting them, is by wetting it with the saliva from the tongue; but, previous to doing this, the adhering diamond-powder is most carefully brushed off from it, with a small short-haired brush.

It may, perhaps, seem superfluous to state, that when one facet or flat surface is produced upon each stone, in the manner above described, they are shifted in the cement, which, for that purpose is warmed over a candle; and the stones are then so placed as to bring each into a position to have another principal facet formed thereon; and when all the large facets are formed that are necessary, this department, technically called "*cutting*," is completed.

On polishing Diamonds.—Having now explained two of the great and principal divisions of this art, namely, those of splitting and cutting, I have to treat of the third and last branch of it for ornamental use, that of *polishing*; by which the *wonderful lustre* that is possessed by this peculiar substance only, is brought out, to delight the ravished eye of the beholder, when properly set by the skill and taste of the jeweller.

As the methods of fixing and holding the diamond for the purpose of *polishing* it, are different from those I have above described in the process of *cutting*, I shall proceed to give a particular description thereof.

A small hemispherical cup, made of copper, and filled with soft pewter solder*, is placed upon a charcoal fire, and the solder being *barely melted*, the cut diamond is placed upon the surface of the solder, and the workman presses it down, and imbeds it so deep that he is enabled to bring a small quantity of the melted solder, over or around the upper part of the stone, by which it becomes nearly enveloped in the mass of metal; one of the large facets, which have been produced by cutting, being the only part of it which is left uncovered and exposed to view.

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* One of the *fusible metals* would seem to be peculiarly fit for this purpose.—EDITOR.

This part of the operation of fixing rather alarms a stranger, or one not accustomed to it, for fear of the workman burning his fingers; but, nevertheless, it is found that the melted metal can no way be so well managed as with the bare fingers; and, although it does at first sight appear to be an insurmountable difficulty, yet the great dexterity and tact acquired by experience enables the workman to effect that with perfect ease, which thus excited our astonishment.

There is a copper pin affixed to the cup, which projects from it in a perpendicular direction; when the cup is inverted, and the stone is placed downwards, this pin is fixed into the jaws of a pair of strong heavy iron tongs or clamps, which have two other pins affixed in them, to support them at one end, whilst the cup and its pin (technically called by the Dutch name *dop*), forms a third leg, or bearing, for the opposite end of the tongs.

By this simple, and apparently rude contrivance, the position of the facet to be polished may be universally varied, an object of the greatest importance to the workman; for, as the pin which projects from the cup is cylindrical, it readily permits the inverted cup to be turned horizontally; and, as the pin is made of copper, it also admits of being bent, so as to place the plane of the facet to be cut, at any angle that may be most convenient or necessary. Another very nice adjustment is likewise obtained by merely placing a slip of paper, or paste-board, under either or both of the two legs or pins before mentioned.

Those persons who are in possession of finely cut and polished diamonds, will receive much gratification in examining the sharpness, truth, and beauty of the facets, which have been placed contiguous to each other, and form such beautiful intersections of planes, produced by the seeming rude and simple means I have just described.

It may very naturally be asked by many persons, why some of the improved machinery of modern contrivance has not been introduced to facilitate, and give perfection to an art, that seems to be conducted upon such rude and simple principles? For goniometers have been contrived to measure the angle of crystallized substances, even to the smallest fraction of a degree; and machinery has also been constructed to give the most perfect forms and representations, or I may more properly say, imitations of crystallized objects, with a most unerring certainty. To this I answer, that such improvements, as they are called, are indeed *possible*, but it is very doubtful whether they would also be *profitable*, for it is really surprising to see with what a degree of certainty and precision the work is performed, by the means I have in part disclosed. There may likewise be another possible reason assigned; namely, that if we have, as I strongly suspect, obtained our information and instruction in this art, from the Dutch, they have an old and very prevailing proverb, which is frequently made use of by them, when any improvements are suggested, viz. "*leave well enough alone.*"

I shall now proceed to describe the means which are used to produce those highly polished planes which we so much admire, after the diamond has been cut, and is held in a very proper position, by the very simple means which I have above mentioned.

The mill commonly used to polish diamonds consists of a horizontal band-wheel, of six feet in diameter; the upright axis of this wheel has a crank formed upon it, which is actuated by a connecting rod, attached to the bar of a swinging frame of wood, turning upon hinges or pivots, at one end of it, like a gate; and which is kept in a vibratory motion by the power of a man, or, if much work is placed on the mill at one time, two men are employed*.

A band from this horizontal wheel passes around a pulley, of about two inches in diameter, which is affixed upon the vertical axis of a flat circular cast-iron disc, or plate, about twelve inches in diameter. This plate is technically called a *skive.*

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* This simple and excellent mode of applying the power of men to actuate machinery, very much resembles that of rowing boats; especially if the men were also to be seated in the *rowing posture*; a mode of producing the greatest effect from the muscular powers of the human frame.—EDITOR.

The upper surface of this skive is turned very flat and true, in a lathe, and then the diamond-cutter proceeds to prepare or roughen its surface, in the following manner:—

He first rubs the whole of the upper flat surface of the skive over with a common rough grit-stone, such as is used by shoe-makers to sharpen their knives with; but he is very careful to move the stone constantly in the direction of tangents to a circle, of about one-third the diameter of the skive. By this means, the whole surface of it becomes covered with coarse furrows. A smoother grained stone is then applied to the whole surface of the skive, but in the direction of radial lines; and this operation is continued until the furrows formed by the first stone are nearly obliterated, or, it may be more proper to say, until a sort of granulation is formed on the surface, which is compounded of both systems of movement, the tangential and the radial.

I have been thus particular in describing this part of the process, because I was informed that much of the success will depend upon a strict attention being paid to these directions.

The next thing to be done, is the charging the skive with diamond powder, I mean such as I described was produced by the abrasion of the diamonds in the process of cutting them. This is effected in the following manner:

After the skive has been prepared or granulated as described, it is fixed in the mill, and some of the diamond-powder mixed with olive oil is spread over the granulated surface, and the broad facet of a stone, already polished, being affixed in the dop, or copper cup, it is fixed in the tongs, and the polished surface of the stone being placed upon the skive, and a proper weight laid upon the tongs, it will be found when the skive is put into rapid motion, that the diamond-powder so applied, will become imbedded in the surface of the skive; the stone already polished, thus acting as a species of burnisher for that purpose*.

As, however, this will only take place in the space of a very narrow circle, unless, indeed, the facet should be on a very large stone; so it will be necessary to move the stone to a fresh position, as soon as that portion of the surface of the skive upon which it is used is found to be sufficiently charged; and so on, by repetition, until a sufficient part of the surface of the skive is prepared, when it will be ready to polish and finish any diamonds which have undergone the process of cutting, as already described.

When the cut diamond is fixed in the dop, and that is adjusted in the tongs, the stone is placed upon the skive, which, being set in motion, if the diamond be examined in the course of from ten to fifteen minutes time, the facet will appear to have lost a part of the grey colour it had obtained from the process of cutting, and a brilliant lustre or polish will begin to appear, which is solely produced from the imbedded powder with which the surface of the skive is charged.

This is, however, a very favourable description of the process, for it sometimes happens that, after much time has been bestowed upon the facet, it will be found that not the least portion of it is polished; in which case, the workman must turn the dop round upon its axis, and by that means present the facet to the action of the skive at a different angle. It is not unfrequently the case that a great variety of angles must be tried before the skive will produce any effect, which is entirely owing to the peculiar arrangement and stratification of the particles of the stone, depending on the laws of crystallization.

After one facet is polished the diamond is turned, and

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* Exactly as the rouge is burnished into the surface of the laps formed of a mixture of tin and zinc, which are used at Geneva, for cutting and polishing gold-work. See Vol. I. *Technical Repository*, page 485.—Editor.

and again refixed in the solder, in a new and suitable position for polishing another facet; and so on, until the the stone is completed.

If the diamond in its grey state, as it appears after cutting, was to be applied upon the skive, before the already polished diamond had burnished and imbedded the diamond powder into its surface, it would immediately act upon the surface of the iron plate, and cut it into furrows, without itself being at all acted upon by the diamond powder, however great the quantity might be that was applied upon its surface.

It may be necessary to observe, that when a facet begins to show a gloss or polish upon it, it may then be also used to charge the skive with diamond powder, in place of a stone, which is already polished.

I have to call the particular attention of your readers to this peculiar effect, of thus charging metal with the powder of the diamond; and by which means we are enabled to make a tool that is capable of cutting, or rather of polishing the diamond itself. I am the more particularly anxious to impress this effect upon their minds, because there are other modes of charging metal with particles of diamond; and by which means abrading or cutting surfaces or edges are formed, which act very similarly to the teeth of a file; but with this difference, that they can be, and are used to cut and give forms to substances of greater hardness than tempered steel could by any possibility be made to act upon. The ruby, and every one of the hardest gems, not excepted.

References to the Figures.

In plate I. fig. 1, A is the mahogany box, used by the diamond cutters. B the rim of steel around the edges of the box. C C the two steel pins affixed in the steel rim. B D the brass-plate, with minute holes in it, serving the office of a sieve. E E the two-sticks or handles, applied against the two pins C C, and holding the two diamonds which are to be cut, by means of the two masses of cement F F, which are applied upon the inner ends of the sticks.

In fig. 2, is part of the stand or table of the diamond-cutters' mill. H a portion of the cast-iron skive. I the tongs, formed in two similar parts, their front ends being bound together by means of the screw K; and they are also held in their proper situation by two steady-pins. I L are the two-pins, serving the office of feet to the tongs, resting upon the table; and one of them having a piece of paper or paste-board M placed underneath it, to elevate it. N the copper wire affixed to the copper cup or dop O, which contains the diamond P, which is to be polished, and which is firmly retained in the cup by soft solder. The copper wire N is shown as being held in the tongs; and the diamond P as resting upon the skive, in the act of being polished.

(To be continued.)

II.—*Experiments and Observations on some Alloys of Platinum.* By Thomas Cooper, M. D., *President of the College of South Carolina, U. S.*

To Dr. T. P. Jones, Editor of the Franklin Journal.

Dear Sir, *College, Colombia, South Carolina, Feb. 24,* 1827.

I read always with great satisfaction your very useful publication, the Franklin Journal. It deserves encouragement, and I hope it will meet with it.

You gave us, some time ago, a process from some German chemist, for making a gold-coloured alloy, by means of virgin platinum. I tried the proportions indicated with pure malleable platinum, and found the recipe worthless. No furnace or forge, urged with a fire of wood charcoal, can possibly melt the mixture prescribed. The platinum I used, was some I bought of Dr. Bollman, procured by dissolving the crude platinum in nitro-muriatic-acid; precipitating by sal ammoniac in solution; stopping so soon as the brown precipitate of palladium appears; washing the nankin coloured precipitate *moderately* in water, drying it; heating it in a flat vessel, under a muffle, to drive off the nitro-muriatic-acid; collecting the grey coloured metallic powder; compressing it in an iron-box with a powerful screw; alternately hammering it, gently at first, and annealing it, till it will bear extension under the hammer. My specimens are of specific gravity 20.8. In the following experiments I used this platinum, rolled thin and cut into small pieces.

I took of copper, by weight, 16 parts; platinum 4 parts; metallic zinc or spelter, 3 parts. I melted the copper first, and then threw in the zinc and platinum, folded up in paper, adding some resin. The heat was then kept up for half an hour, and the alloy poured into an ingot-mould, greased. I had tried three experiments with different proportions of the materials, before I settled upon this.

The result was, an alloy, well fused; clean, even surface, compact, of a very passable gold-colour, and bearing an excellent polish. Other proportions of the metals employed may answer better, but this answers (as I think) very well. If too yellow, add a little more copper: if too red, a little more zinc.

I am informed that although zinc will not unite chemically with copper in a greater proportion than 25 per cent., yet the brass makers by pouring the zinc into melted copper, make a brass, containing 35 per cent of zinc. In my mixture the zinc is about a fifth part. If I were to suggest any alteration, it should be to increase the platinum to five parts instead of four.

These experiments led me to believe that platinum would be a great improvement to speculum metal. I therefore made the following mixture, three several times, viz. Copper, 320 grs.; tin, 165 grs.; zinc, 20 grs.; arsenic, 10 grs. twice using the white arsenic, and once the metallic arsenic (the fly-stone of the Philadelphia shops.) In all 515 grs. The results were, a bluish white, silvery mixture, very dense and very brittle, bearing a fine polish, having a considerable increase of specific gravity; such as I remember to have procured formerly, on repeating Mr. Edwards' receipt for speculum metal. The above proportions are very nearly his, and Mr. Little's, as you will immediately recognize. The specific gravities were, 9.—9,116 and 9,3. I remelted them altogether, and the specific gravity of the mixture was exactly 9,1. The colour, the fracture, and general appearance, were manifestly improved by remelting.

I then took the same quantities and proportions as at first, adding to them 60 grains of platinum, making the whole weight 575 grains. It melted into a yellowish-white very close grained alloy, bearing a far better polish than any of the specimens above mentioned. Specific gravity, 9,472. The platinum appeared to be a manifest improvement. The yellowish colour (which I did not expect) may be no disadvantage, as the yellow ray is much the most luminous. The acquisition of density in the specimens after Mr. Edwards' and Mr. Little's proportions, and the apparent defect of density in the specimen with platinum, I know not how to account for, except from the general fact that no alloy follows the arithmetical proportion of specific gravity.

Specific gravity of the copper used	8,487
Of the platinum	20,8
Of the tin (grain tin,)	*not taken.*
Of the zinc	7,078
Gold coloured alloy	9,0487
Of the white coloured speculum metal	9,1
Of the speculum metal with platinum of a yellowish white colour	9,472

The superior density of this last alloy, I suspect to be owing to the arsenic.

I am, dear sir, your friend and servant,
THOMAS COOPER, M. D.

P. S.—I hope some ingenious workman in metals will repeat these experiments.

III.—*On Professor Amici's and other Microsopes.*

By the EDITOR.

WITH FIGURES.

THE celebrated Professor Amici, of Modena, in Italy, having recently arrived in this metropolis, the editor immediately waited upon him, and was kindly gratified with a sight of the superb collection of reflecting and refracting microscopes, and other superior optical instruments, which he has brought with him.

He has since, by his invitation, repeatedly witnessed the performance of his microscopes in comparison with others, brought for the express purpose, and with the same test objects; and the result appears to be, that his *reflecting* microscope is a most capital instrument indeed, under moderately magnifying powers; but his *refracting* one, which is composed of a compound object glass, formed of two achromatic lenses, each consisting of three lenses; a right angled prism, to change the direction of the line of vision from a vertical to an horizontal one; and an astronomical eye-glass, greatly exceeds it for every purpose, and is indeed a superior instrument.

The result of the comparisons appeared to be in favour of Professor Amici's refracting microscope, and of Tully's achromatic and Cuthbert's miniature-copy of the professor's reflecting microscopes; and which may, therefore, be deemed the most perfect microscopes hitherto constructed.

It would be invidious to mention the names of other makers whose microscopes were thus submitted to a fair competition; suffice it to say, that one, brought over from Paris, and the performance of which was highly spoken of, would not bear any comparison with the three before mentioned ones, when the *difficult test* objects were under examination.

Professor Amici very justly observed to the Editor, that it was not only necessary to possess a good microscope, but likewise to be able to employ it in the best manner, and he illustrated this remark, by showing him his mode of examining the skin which covers the undersides of the leaves of vegetables; for which purpose he raised the skin of a leaf upon one of the ribs a little, with the edge of a sharp penknife, until he was able to tear a small portion of it off. This he placed between two slips of glass, previously wetting the inside surface of each of the slips with water, and thus afforded a beautiful object under the microscope. The water producing a great degree of clearness, and rendering the examination of the skin of the leaf a most pleasing one.

On returning home, the Editor immediately proceeded to make trial of this method. He had indeed only his *Varley's single microscope* to trust to *for accuracy of vision*; but even with this, and with lenses of the tenth, twentieth, and thirtieth parts of an inch focus, and the aid of a slip of plate-glass, ground so thin as to be capable of being used, even with the lens of the thirtieth of an inch focus, he was able, by following the professor's directions, to gratify himself with most delightful displays of the admirable skill manifested in the organization of even the humblest plants!

He found the construction of two of these objects so singular, that he has thought them deserving of being engraved; and, accordingly, has caused Mr. Turrel to insert them in plate I.

Fig. 3, represents four of the very singularly formed hairs, which are found to cover the skin of the leaves of the common Virginia stock. They are attached to the skin by a stalk in the middle of the hair, and which is represented by an oval in each. Two of them have three jagged and pointed branches, and two of them four, crossing at acute angles; although some of them are also found, crossing at right angles. Some, indeed, have no branches, but are merely straight, pointed at each end, and joined to the leaf in the middle.

The editor had before only met with one instance of a similar construction to the latter of the above hairs, and that was, in some hairs which covered parts of a plant from New South Wales, that country of wonders in natural history. These were attached to the plant by foot-stalks in the middle of each, thus leaving their sharp ends projecting, to arrest the progress of any small insects, in their attempts to reach the forbidden fruit. One of these hairs is shown in fig. 4.

But a still more extraordinary instance of a curious structure, he found in the downy covering of the stock gilliflower. Upon placing a minute portion of the skin of the stem near the flower, between two slips of plate-glass previously wetted with water on their inside surfaces; and then sliding the one slip over the other a little, backwards and forwards, he succeeded in detaching portions of this down from the rest. These, under the microscope, presented an appearance, nearly resembling that shown in fig. 5, where its singularly formed stem and branches are exhibited. Nor indeed was it, until he had compared several of them with each other, that he could be satisfied that this really was the general appearance of the down.

Professor Amici has brought with him from Italy the necessary lenses, prisms, &c. for fitting up his refracting microscopes; and we wish it were likely that such could become common in this country; this, however is hardly probable. Mr. Tully's achromatic lens is still less likely to be manufactured by any other optician, on account of the great labour and skill requisite in working the three lenses composing it. Mr. Cuthbert, we are glad to say, finds constant employment, in making his minute reflecting microscopes on Professor Amici's principle; but they require so much time, skill, and delicacy to be employed in their manufacture, that it is hardly to be expected many will be constructed. Even the best of the usual compound microscopes, although they are indeed very pleasant instruments for ordinary use, cannot be trusted to, in the examination of *difficult test* objects. What, therefore, should be done to best gratify the increasing wishes of the public, in regard to the accurate examination of objects by the microscope? We are almost afraid to say, that we must come to the same conclusion with the late Mr. Varley, that *well worked and mounted single lenses,* such as his, are greatly preferable to the usual compound microscopes, for in them the errors are confined to two surfaces only, and are therefore less likely to be injurious than in those microscopes, where a multiplicity of lenses are combined, and their inaccuracies consequently increased.

We can then only conclude in recommending, in point of cheapness, facility of execution, and distinctness of vision, the extended manufacture of good single microscopes, upon the plan adopted by Mr. Varley, and published, with descriptive figures, in the ninth volume of our *Technical Repository,* page 258, and of the merits of which microscope we can speak, from an experience of upwards of twenty years. It is true, indeed, that the field of view is not so extensive as in the compound microscopes, but such parts of the objects as can be displayed are distinctly shown, which, for most purposes, is fully sufficient.

It would be a desirable thing were opticians to grind and polish slips of glass to the degree of thinness above-mentioned; as, without that slip, the editor could not have been able to make his experiments. It is true, that where pressure and friction are not required mica, or talc, completely answers the purpose; and, indeed, for still higher magnifying powers, as in using lenses of the 60th part of an inch focus, it is absolutely necessary. This glass slip formed part of the collection of superior microscopic apparatus, described by us formerly, and as being contained in a small cabinet made on purpose to hold it.

IV.—*On beautiful Microscopic Configurations, produced by the mixture of three different Salts.* *By the* EDITOR.

WITH A FIGURE.

WE having, many years since, pretty well exhausted the subject of the configurations produced by the then slender stock of saline preparations, (although in the present day, we have no such cause of complaint, from the exceedingly numerous list of saline combinations continually increasing upon us), determined upon trying the effects of salts in double and treble mixtures; and, notwithstanding that we cannot boast of great success, yet one, in particular, afforded us an ample remuneration for our trouble.

In making a mixture of borax (borate of soda), sal-ammoniac (muriate of ammonia), and Rochelle salt, (tartrate of potash and soda), we found most beautiful *hexagonal configurations*, resembling the cells in a honeycomb, and which frequently extended themselves, with the most perfect uniformity, over a considerable extent of surface.

In plate I, fig. 6, is a representation of one of these hexagonal configurations. It commences by forming three rays, each proceeding from one centre at an equal angle; these again subdivided at their ends, at a similar angle with the former ones; and so on, until a numerous assemblage of them is thus formed.

It has not hitherto been in the Editor's power to ascertain the exact proportions of the three salts; he having hitherto succeeded, by merely making mixtures of the solutions of them, and trying the effect thereof under the microscope, by laying a drop of the mixture upon a slip of glass, and holding it over the clear flame of a candle, until it began to form configurations round the edges of the drop, when it soon began to shoot into longer ones, and might be placed under the microscope, when, if not satisfactory, he varied the mixture until the desired result was obtained.

A vast variety of other configurations also form themselves, at the same time with these hexagonal ones in the same drop, some shooting at right-angles; others in rhomboidal figures; but these hexagonal ones are the most beautiful. They are not, however, permanent; but are subject to deliquescence, and must, therefore, be delineated as they are formed, if it is intended to preserve their figures.

III.—*On an easy Way of dividing Plates of hardened Steel, such as Saw-Plates; and also of perforating them, when necessary.* By Dr. Thomas P. Jones.*

Workmen frequently wish to divide a broken saw-plate, for the purpose of coverting it into scrapers, square blades, or small saws; this is usually attempted by notching it to a small depth with a cold chisel, and then breaking it along the lines so made. When the plate is very hard, this method will not succeed, and the plate is frequently destroyed in the attempt. When it does succeed, the plate is generally twisted and buckled in the operation.

The Editor had a hard plate, which he was desirous of cutting into strips, to make small saws for a working model of a saw mill; this, although too hard to yield to the chisel, he divided with the utmost facility, piercing the ends at the same time, for the purpose of stretching the saws; this was effected in the following manner. The saw plate was made sufficiently warm to melt bees'-wax, which was then rubbed over it, so as to coat it completely on both sides, when it was suffered to cool. Lines were then drawn through the wax on both sides of the plate, with a steel point. It being of great importance that these lines should be exactly opposite to each other, this was effected by making a saw-kerf in the strip of wood which was used as a straight-edge, and the plate being placed in the kerf, the opposite lines were easily drawn. A mixture of sulphuric acid (*oil of vitriol*) and water had been prepared, and suffered to become cold; the proportions about one part of acid to six of water. The saw plate was then placed in a common queen's-ware dish, sufficiently large to contain it within the rim, and the acid and water were poured into it, so as just to cover the saw-plate; in about half an hour it was taken out, washed in clean water, and the wax scraped off, the lines having been bitten in to a sufficient depth to cause the plate to break with great ease. Some pieces which were left in too long, were eaten quite through, and the edges rendered rough and indented by the action of the acid.

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* From the *Franklin Journal.*

At the ends of the plates, where holes were wanted, the wax was removed on each side; it was found necessary, sometimes, to insert these ends in the fluid, longer than the time allowed for the action on the lines; this, however, depends upon the thickness of the plate. Circular saws may be readily made in this way, and their centres perforated to any size. Square or round holes may be made through a plate of one-fourth of an inch in thickness without the slightest difficulty. To effect this, after covering the part with wax, and scratching through it, in the way directed, a wall, or bank, of wax is to be placed round it, so as to form a cup, into which the liquid may be poured; this operation must be repeated on the opposite side, and when the lines are bitten to a good depth, the piece may be punched out.

Whenever the plate to be divided, or perforated, is large, a bank of wax may be made to surround the parts, or the acid and water may be repeatedly washed over the lines, until the corrosion is sufficiently deep.

Care should be taken to employ good, clean wax; for the acid will find its way through it wherever there are any specks of dirt, and thus injure the face of the plate. Engravers' etching ground would be a better article than wax, but the latter is easily obtained, and, if pure and clean, will answer very well.

Saws and other tools of iron or steel, may be readily marked with the name of the owner of them, by the foregoing process.

Note by the Editor.

Mr. Turrell, our engraver, has long since thought of this excellent method of dividing saw-plates, and particularly for the thin, narrow *watch-spring saws*, used by the saw piercers, to which it seems peculiarly applicable; and is far preferable to the ordinary mode of dividing them by means of shears, which inevitably distorts them, and renders them less fit for use.

IV.—*On freeing the Thames Tunnel from Water. By Mr.* Peter Keir, *Engineer.*

Engine Manufactory, College Street,
Camden Town, June 18, 1827.

Sir,

Every one engaged in excavation, is aware of the liabilities of an accident, similar to that which has occurred at the tunnel; and Mr. Brunel appears, throughout, to have adopted such measures as were the most likely to guard against it. But, as the measures to which he has resorted *to repair the damage,* have hitherto proved ineffectual, I consider it to be my duty, as well as the duty of every one, who has been practically engaged in works of a similar nature, to propose, with due deference, the adoption of such measures as, under the circumstances of the case, seem to be the most economical and effective.

The rise and fall of the tide at the Tunnel is from eighteen to twenty-four feet; and, as the Tunnel communicates with the shaft, the ebb and flow of the water there, must be in a similar proportion. Therefore, as the water rises at the rate of about four feet per hour, and the shaft is fifty feet in diameter, 130 cubic feet, more or less, must pass through the hole every minute. This is a very considerable velocity, and at every tide must enlarge the size of the aperture. Mr. Brunel is aware of the obvious necessity there is to counteract this, and he has in part effected it, by applying a steam-engine to pump the water from the shaft, in the same proportion, that it would have a tendency to escape, during the ebbing of the tide. But though the water is by this means prevented returning through the hole, it is allowed to have free access into the shaft, during the rising of the tide; consequently, but one half of the mischief is avoided.

The measure, I therefore propose is, 1st, that the shaft of the Tunnel shall be immediately filled with clay to a sufficient height, to prevent either the ingress or egress of the water through the aperture; but that sufficient room shall be left for the action of the pumps; 2nd, that when, by the filling up of the shaft, the water in the Tunnel has become stagnant; the ground where the hole is, shall be made good by puddling with clay, and such other materials as are commonly used in cases of a somewhat similar nature, and in the formation of mill-dams, where the velocity and quantity of water to be resisted is very great; and 3rdly, that when this is completed, and the water pumped out, the clay shall be removed from the shaft, and the tunnelling, at that part where the hole was, be recommenced, and carried on with the same precaution, that Mr. Brunel has so ingeniously displayed throughout.

I would also advise, that temporary flood-gates be constructed, as near to that part of the tunnel where the workmen are employed, as may be deemed proper; and that contrivances be so adapted to them, that, in the event of any similar accident hereafter, the workmen may escape through; and, by closing the gates, guard against destruction to themselves, and the necessity of again filling up the shaft, to prevent the ebbing and flowing of the water, as is so injuriously the case at present.

The expence attendant upon this mode would be trivial, compared with what would be incurred by the erection of a coffer-dam, which, according to the opinion now current, seems the course the most likely to be ultimately pursued. Indeed it is a matter of simple calculation, and may be estimated to a fraction: for, as the clay is still remaining in the possession of the company, the only data required, is, at how much per load persons will contract to cart the clay from where it now is, and shoot it into the shaft; and at how much per load, they will, when required, afterwards extract it?

I am, sir, your obedient servant,

To T. Gill, *Esq.* P. Keir.

V.—*On extracting the Points of Drills and Taps when broken in holes made in articles of Silver or Brass, without injuring the articles, and also of removing spikes from the touch-holes of brass Cannon.*[*]

To Dr. Thomas P. Jones, Editor of the Franklin Journal.

Sir,

I was particularly pleased with your method of "dividing plates of hardened steel," given in a late number of your journal; and, perhaps, another instance of the advantage which the mechanic may derive from a knowledge of chemical science, may prove equally acceptable to your numerous readers of that class.

When Dr. Hare's compound blow-pipe was first introduced I constructed one. In drilling the silver nozzle, the drill broke at the moment it was about perforating the end, and a piece of the drill, of about one eighth of an inch in length, remained in the hole. As I had succeeded in drilling the other hole the accident was particularly mortifying. Being unwilling to destroy the nozzle, on which I had bestowed considerable labour, it occurred to me to try whether diluted sulphuric acid (oil of vitriol) would not dissolve the broken part of the drill. For the experiment I, at night, put the nozzle into a wine glass, covered it with water, and added sulphuric acid by drops, until I perceived a succession of globules of gas arise from the hole, and left it until sun-rise next morning, when I had the satisfaction to find the steel entirely dissolved; and, with a fine pointed punch, I finished the the orifice of the nozzle.

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[*] From the *Franklin Journal.*

This winter I had occasion to turn three brass balls, one inch in diameter, and which were tapped half an inch deep. As I am not a professional mechanic; I, from a deficiency of tools, often find it necessary to make one tool answer as many purposes as I can; and, on the present occasion, finding I could centre the tap, with which I screwed the balls, in a chuck, I undertook to turn them on that, as a substitute for an arbor. With care two were finished; but, with the last, I suffered the turning tool to catch one of the corners of the square part of the tap, and broke it off even with the circumference of the ball. As I had a pressing occasion for the ball, and had no other cast, I immediately put it in the bottom of a broken oil-flask, covered it with water, and added about one-sixth part of sulphuric acid, and placed the capsule on a stove, with a handful of ashes interposed as a substitute for a sand-bath: other business requiring my attention, I did not examine it until after three or four hours, when I found the tap entirely dissolved, without the least injury to the threads of the screw.

I think it probable that the above method would be found sufficient to *unspike brass cannon*, and thus supersede the necessity of re-melting and casting them, or of spoiling the touch-hole in the ordinary way of drilling. For this purpose, a flat bar of wood, three or four feet longer than the gun, would be required. At the distance of the touch-hole from the back of the chamber, place on the wooden bar either a lump of fat lute, a mixture of bees'-wax made soft by the addition of oil, a cone of lead to enter the touch-hole, or any other substance which would resist the action of sulphuric acid. By using the lower edge of the muzzle of the gun as a fulcrum, and depressing the projecting end of the bar, the lute would cover the touch-hole, or the cone enter the same, and render it sufficiently tight to prevent any liquid passing down. A cup of wax should then be raised around the touch-hole, on the outside of the gun, of sufficient capacity to contain a pint, or more, of diluted sulphuric or muriatic acid; and, if the experiment were made in a temperate atmosphere, I think the gun might be rendered serviceable, without any other injury than it received from driving the spike.

H. W.

VI.—*On an improved Turning-Lathe, made by Messrs.* MASON *and* TYLER, *Engineers, of Philadelphia, U. S.*

WITH A PLATE.

IN the last volume of our *Technical Repository*, page 304, we gave a short account of some improvements made by Mr. J. Lukens, engineer, of Philadelphia, in forming cast-iron wheels, and in the construction of lathes; and, in page 305, we also gave his method of cutting original right or left threaded screws in the lathe. We have since then received the *Franklin Journal*, for March last, containing a plate and description of a similar lathe, made by Messrs. Mason and Tyler, of that city; possessing also other improvements, which we now lay before our readers, together with our own and Mr. Lukens's additional remarks respecting it.

At the second annual exhibition of the *Franklin Institute* of Philadelphia, a turning-lathe, made by Mr. Rufus Tyler, excited much attention among those who were judges of that useful article, both on account of the perfection of the workmanship, and the improvement in its construction. The sliding parts traversed with an equability and ease which left nothing to be desired in that particular. The front centre, which, as may be seen in plate II., was a sliding bolt, might be used without the tightening screw, in turning steel or other metals; and, in fact, the large and small lathes, in Messrs. Mason and Tyler's workshops, although provided with tightening screws, are generally used without them. The cast-steel screw by which this centre was worked, might be moved its whole length without the slightest shake, *drunkenness*, or inequality; the centering appeared also to be absolutely perfect, and good workmen are well aware of the difficulty of attaining this high degree of accuracy.

In constructing this lathe Mr. Tyler availed himself, not only of his own experience, but of the improvements made by Messrs. *Lukens*, Mason, Clarke, Baldwin, and others, among our best mechanics. Simplicity of structure was particularly consulted, as the main object was, to produce a lathe adapted to general use; it is represented, therefore, without those appendages which are designed for particular purposes only, such as guides for cutting screws, and eccentric and oval chucks; these, however, may, of course, be attached to it, when desired.

In plate II., fig. 1, A is the cast-iron bed of the lathe, with three feet to it, which serve to connect the laths or shears firmly, at a proper distance from each other, also leaving the spaces between them unobstructed by cross-bolts, as well as permitting the sliding-head and rest to be taken out, without detaching their holdfasts.

B, the standing-head, cast in the usual way.

E, the sliding-head.

F, the front centre sliding-bolt. This is a cylinder, sliding in a hollow cylinder, which is formed in the top of the sliding-head. It is moved backwards and forwards by means of a left-handed screw, which works in a female screw within it.

G, the rest, cast with a groove underneath its bed, to receive the head of its holdfast.

Fig. 2.—A section of the standing-head, with its mandrel and drill-chuck. The drill-chuck C has its shank or stem made slightly conical; and is made fast in the mandrel by its key, D, passing through holes made to receive it, in the mandrel and in the stem of the chuck.

The drill-chuck has a conical hole in it, which, in the figure, is represented as containing a steel point. When drills are fitted into this hole they are sufficiently firm for ordinary drilling; whilst they will generally turn round, in case of catching, or other extraordinary resistance, and thus be preserved from breaking.

The mandrel runs in a conical steel collar, as may be seen in the section.

The conical end of the back centre is truncated, and made flat; it works against the slightly rounded end of a square block of hardened steel, which is let into the mandrel for that purpose, and sustains the pressure in drilling, &c.; thus preventing that great increase of friction which is produced when the ordinary sharp-angled cone is employed.

The conical end of the back centre is made somewhat more acute than the conical opening in the mandrel; which lessens the friction, and gives free admission to the oil.

Fig. 3.—E, a section of the sliding-head. The front centre is represented as inserted into the bolt at F. At the opposite end is seen the left-handed screw, which is attached, by a collar, to the hollow cylinder of the head, with which it forms a casing that secures the bolt and screw from the entrance of chips and dust.

Fig. 4.—An end view of the laths or shears, and foot, with the sliding-head and its holdfast.

The inner edges of the laths are bevelled, and the sliding-head has an angular piece screwed upon its bottom, which is nicely fitted into the bevels of the laths. Should any wearing take place, this is compensated by a thin piece of metal, which is to be inserted between this bevel-piece and the head.

Fig. 5.—A screw-chuck; to be substituted for the drill-chuck, shown in fig. 2.

Fig. 6.—A section of the bed of the rest, showing the shape of the groove in it.

Fig. 7.—An end view of the treadle, with its upright standard H firmly braced to it; and the connecting-rod I, attached to it.

The form given to the connecting-rod at K, where it fits upon the neck of the crank, admits of its disengaging itself when the treadle is obstructed; whilst it is securely retained in its place under ordinary circumstances, the curved projecting plate attached to it, resting upon the neck of the crank.

A crank, with a short connecting-rod, turns one of its dead-points much more quickly than the other; in the arrangement of the crank in this lathe, advantage is taken of that peculiarity; the slower turn takes place at the bottom of the tread, and the too quick return upon the foot, which occurs in the common mode, is consequently obviated.

The lathe is most conveniently fixed in the way represented in the plate; that is, screwed upon a table, which is supported upon a nest of drawers at each end; and having a space between them for the wheel and treadle.

The wheel is of cast-iron, with its arms *curved*, to prevent the breaking from contraction, at the time of casting. The holes in the arms are to admit screws, to affix a smaller wheel, when a slow motion is required.

In the old mode of fixing the treadles of lathes, the lever was of the third kind, and the crank was, consequently, made long. In the modern mode shown, the lever is of the second kind, and the crank must be proportionally short, or the rise of the foot will be too great.

This lathe is equally suitable to the use of the professed turner and the amateur, as it is neat, strong, easily adapted to various purposes, and not liable to get out of order.

Remarks by the EDITOR.

Mr. Lukens thinks that this mode of preventing the catching of the treadle, when any thing obstructs it, though different from his, as described by us, is equally good, and, perhaps, more easily made. The idea of fixing the drills in the chuck, merely by the tapering or conical form given to their stems, so as to permit them to yield in case of accident, is good. We shall furnish an excellent, though different application of that principle, in our description of the late scientific Mr. Samuel Varley's lathe-mandrel and chucks, contained in the present Number.

VII.—*On the improved Lathe-Mandrel and Chucks, made by the late Mr.* SAMUEL VARLEY. *By the* EDITOR.

WITH FIGURES.

MR. Varley was a watch jeweller, amongst his many other avocations, as also an optician, and, consequently, had occasion for numerous small chucks, so fitted to his lathe-mandrel, as to run with great truth and accuracy, at the same time that they could be readily fitted upon it, and removed as easily.

He accomplished these desirable objects in the following simple and convenient manner:—The outer end of his lathe-mandrel was accurately formed into a conical shape, of such a degree of taper, that a metal or hard wood chuck fitted upon it, should bind itself fast, on being twisted round upon the cone, at the same time that it should not be so nearly cylindrical as to endanger the bursting or splitting of the chucks.

In plate II., fig. 8 represents this tapered end of the mandrel; and fig. 9 a metal chuck, whose hole is rather deeper than the length of the aforesaid taper end of the mandrel, but of the same diameters and degree of taper. These chucks he often formed of type-metal, softened a little with lead, or of lead hardened by tin, regulus of antimony, bismuth, &c., and he cast the melted mixture in wooden or sand moulds, holding an upright conical piece of steel within them to form the taper holes in the chucks upon; this piece of steel being longer than the taper end of the mandrel, and rather less in diameter.

The nose of the mandrel had likewise a female screw within it, as shown by dotted lines in fig. 11, in order to receive the screwed ends of other small chucks; but, for accuracy of fitting, Mr. Varley always preferred the cone to the screw.

Fig. 10 is a representation of one of these screw chucks. Its outer end is turned hollow, and is filled with cement to hold a lens, in order to grind or polish it. By reason also of the hollow formed in the end of the chuck, the lens is in contact with a circular ring of bearing only, and can thus be adjusted with great truth and accuracy.

Mr. Varley also adopted conical holes, for conical stems to fit into, like Messrs. Mason and Tyler, in others of his tools, and always filed or ground these stems in a spiral or screw-like manner, which gave them a very firm hold in the conical holes, when pushed and turned in them.

The degree of taper is of some consequence; it may be formed at angle of about 5° with advantage.

VIII.—*On English Rail-roads, Waggons, Loco-motive Steam-engines, &c.* By ERSKINE HAZARD, *Esq. Civil Engineer.*

TO DR. T. P. JONES, EDITOR OF THE FRANKLIN JOURNAL.

DEAR SIR, *Philadelphia, March 7, 1827.*

WHEN travelling upon some of the rail-roads in England, I noticed that the wheels did not appear to bear hard against the sides of the rails, even when there were short turns in the road. This led me to an examination of the cause, which, as I have not seen it mentioned, in any publication on the subject, I will now state. The wheels of the carriage are wedged on the axle-trees at such a distance apart, that there may be an inch play between the the flanches of the wheels and the rails. The journals, or round parts of the axle-trees are an inch longer than the the brass boxes in which they work, so that the axle-trees may move an inch end-ways, before the shoulders come in contact with the box which is attached to the waggon body. These two circumstances are sufficient to prevent the lateral friction, where the road is nearly straight; but in addition to these, where the road winds considerably, the rail farthest from the centre of the curve is *higher* than the other, the middle of the curve being the highest point, and from that gradually descending both ways till it becomes level with the other rail at each extremity of the curve. The consequence of this is that the load, as the road bends, slides on the axle-tree, towards the centre of the curve; and when the box comes in contact with the shoulder of the axle, assists the exterior rail in turning the waggon from the direct line, so that the rail in fact has only to throw the axle over without any part of the load.

On the Hetton rail-way they are *abandoning the loco-motive engine.* The jarring occasioned by the wheels passing over the ends of the rails, although apparently trifling, is found to destroy the joints so fast as to make it cheaper to maintain *stationary* engines, at two miles distance from each other, with ropes extended between them, to draw the waggons. The buildings for some of the stationary engines were erected when I was there. The loco-motive engines on this road were furnished with the pistons mentioned by Mr. Strickland, which were intended to operate as *springs* to prevent the jar; but upon close inspection, while the engine was travelling, I am convinced they did not move. Indeed it appears to me, that if they did operate at all it would be injuriously, since the connecting-rods will always be carried by the crank-pins to a given point, and if the boilers, with the cylinders attached to them, were raised by the small pistons from the axle-trees, the connecting rods would thereby be rendered too short to pass the dead centres, which must infallibly derange some of the machinery.

On the Fawdon rail-way, the waggons were moved, in part, by stationary engines with a rope extending between them. The rope is placed in the jaws of a kind of vice, attached to the waggon, where it is secured and alternately wound upon drums by the engines at its extremities; its length was that of double the distance between the engines. Where the rail-way crossed a public road, the rope was bent down by friction rollers and carried under a plank bridge to the other side of the road, where it again rose above ground. When the waggon comes to the public-road, the boy who rides on it releases the rope from the vice, the velocity of the waggon carries it over the road, and the boy again hooks up the rope into the vice, while the waggon continues its motion.

By declining the use of loco-motive engines, a great proportion of the expense of the rail-way may be saved, since waggons carrying from one and a half to two tons, can be used with as good economy as those of larger burthen, and they would require a rail-way of only one-fifth the strength of those on which steam-engines are to travel.

It does not appear to be decided whether cast or wrought-iron rails are to be preferred; the former are used on the Fawdon, the latter on the Stockton and Darlington rail-way, and at each they speak most favourably of the kind they have adopted. I saw some of each which are said to have been in use for a number of years; both appeared to wear equally well, the original surface being still visible in each. The length of the wrought-iron rails was certainly objectionable, both on account of the *expansion and contraction* of the metal, and the difficulty of obtaining an *equal bearing on all the props*, only a small proportion of which were in contact with the rails I examined. To remedy this, they propose in future to cut the rails in two at each prop,

I am decidedly of opinion, that in this country (the United States), a rail-way of wood sheathed with iron, would be preferable to any other, and could be kept constantly in order at the least expense. The preparation of the ground to receive the rails would be the same in any case, the labour in laying down the rails very nearly the same, but the *materials* would cost but one-fifth as much as the iron-rails and props. On the plan adopted in England, each prop rests on a detached stone, or in many places a block of old ship timber. These stones or blocks are of *irregular form and size*, and the cast-iron prop is rarely placed on the *centre of bearing, or bed* of the stone or block; the consequence is, that the weight passing over them, *sinks* them unequally into the ground, and gives them a *rocking* motion, which requires the *constant* labour of ramming them up with a bar of iron to bring the rails level and parallel to each other. Severe frosts would also derange them by operating unequally on foundations of different textures. In the wooden rail-way, *sills, embracing both rails,* would be substituted for the stones and props, and the whole would form a *connected frame,* which would reduce the action of the loads to a perpendicular pressure, which can easily be sustained. The construction is so simple than any particular piece can be taken up and replaced as it *decays* with as little detention as *the stones* on the other plan can be put in order, and the interest of the difference of the cost will defray the expense. The wear of the iron sheathing will be so trifling, that it may be considered nearly as a permanent fixture.

Should you deem the above remarks likely to throw any light on the subject of rail-ways, you are at liberty to make any use of them you may think proper.

Your obedient servant,

ERSKINE HAZARD.

XI.—*On large Plantations of Timber and other Trees, made at Butsfield, in Durham. By* THOMAS WHITE, *Esq.*

(*Concluded from Vol.* XI. *of our Technical Repository.*)

THE Larch, I have found by experience, will thrive where no other plants will live. The Birch, though no timber-tree, is a useful wood, affords great shelter, and is almost as hardy as the Larch, as I have fully proved at Butsfield Plantations, which in its uncultivated state had several roads over it, some of which, that lead down the declivities of the hills, had all the soil washed from them by the torrents, nearly to the rock; those roads were planted with small trees of different kinds, making use of a pick-axe to form the holes for their reception. I also planted up all the old quarries, where stone had been got in the same way: there being no soil, I brought a small portion of earth to each plant, and upon those unfavourable spots, where most of the other trees had died, these plants appear to flourish as well as upon a better subject.

When I consider the many virtues of that invaluable and pleasing tree the Larch, I think it a great misforturn that its introduction into this country, was not of an earlier date. About fifty years ago I am told this Alpine plant, was treated as a tender exotic, and planted out with the utmost care and diligence, in our hot beds and hot houses; I am every day more convinced of its utility, both from domestic and foreign intelligence.

I must observe, that though there was not a single tree or bush upon either of my purchases before I began the improvements, a circumstance soon after happened, which convinced me that wood had grown upon the land; for in digging my drains, the roots of large trees were found, also upon the surface of the ground several very large heaps, containing the cinders of iron ore, which metal this country still produces, and it is probable the smelting it may in barbarous times have been the original cause of the present scarcity of wood in some of the northern counties; as there is a tradition prevails amongst the country people that the whole of those waste lands was once a great forest, which was all consumed in smelting the ore, by a kind of foot-blast before the invention of better engines; and that the workmen frequently shifted their ground as the wood or ore decreased, till they had overrun the whole country.

I am making some experiments on the texture of Larch-timber, that I may ascertain its quality for different untried purposes; the result of which I shall be happy to lay before the society at some future opportunity, and if I can in any respect further their general plan by a fuller and better explanation, so as to throw more light upon this useful science which I humbly conceive has not yet been explored to its fullest latitude in this country; I shall think myself highly gratified not only in promoting a work which has so warmly and unremittingly excited my ardour and attention for many years, but shall also think myself much flattered in having the honour to correspond with a Society of gentlemen of such distinguished liberality and ingenuity.

I am, sir, your most obedient humble servant,

To SAM. MORE, *Esq. Sec.* THOMAS WHITE.

XII.—*On the different Black Colours. By the late celebrated* WILLIAM LEWIS, *M.B. and F.R.S.**

(*Continued from the Technical Repository, Vol.* XI. *p.* 369.)

BLACK VEGETABLE JUICES.

THE excellent black varnish of China and Japan, which has hitherto been but imperfectly imitated in Europe, and which was formerly thought to be an artificial composition of resinous bodies, coloured with black pigments, has been discovered, by the later travellers in those countries, to be a native juice exuding from incisions made in the trunks of certain trees. One of these trees, according to the account given of it in Kœmpfer's *Amœnitates Exoticæ*, is that whose fruit is sometimes brought to Europe, as a medicinal drug, under the name of anacardium.

The anacardium itself, as it comes to us, is remarkable for a black colouring juice. It is a kind of nut, with a double shell, containing, in the space between the outer and the inner shell, a fungous substance, filled with a dark-coloured viscous fluid, which is easily forced out, by cutting the nut and squeezing it between the fingers; a little warmth, by liquifying the thick matter, makes it come out more freely; though the quantity obtained, either with or without heat, is not very considerable. This juice, rubbed on linen or cotton, gives a reddish-brown stain, which deepens in the air to a black, and which I have not found to be discharged by washing, and boiling with soap, or alcaline ley. Hence the anacardium is said to be used for marking linen and cotton cloths, and to be known all over India by the name of marking nut.

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* From his *Commercium Philosophico Technicum*, or Philosophical Commerce of Arts.

The cashew nut, called by some the anacardium of the West Indies, and which, in several respects, has a great resemblance to the oriental anacardium, differs from it in its colouring quality, the juice lodged between its shells being much paler, and giving to linen, cotton, or paper, only a brownish stain, durable indeed, but which does not change at all towards blackness.

There are, however, trees, natives of the United States, which appear to contain juices of the same nature with the valuable productions of the East Indies. Of this kind are several, and perhaps the greater number, of the species of toxicodendron, or poison-tree. Mr. Catesby, in his History of Carolina, describes one, called there the poison-ash, from whose trunk flows a liquid, black as ink, and supposed to be poisonous. This reputed poisonous quality, as I have been informed by some gentlemen of that country, has hitherto deterred the inhabitants from attempting to collect, or make any use of it. The Abbé Mazeas, in the Philosophical Transactions, vol. 49, for the year 1755, gives an account of three sorts of the toxicodendron, raised in a botanic garden in France, containing in their leaves a milky juice, which, in drying, became of a deep black, and communicated the same colour to the linen it was dropped upon. The linen thus stained was boiled with soap, and came out without the least diminution of its colour; nor did strong ley of wood-ashes make any change in it.

Several of these trees have been raised in the open ground in England; some of them still remain in the Bishop of London's garden at Fulham, after having been long neglected, and suffered many severe winters—(see a catalogue of the exotic trees in this garden, by Dr. Watson, in the Philosophical Transactions, vol. 47, for the years 1751 and 1752. They appear also to perfect their colouring juices in this, nearly as well as in their native climate. The species called by Mr. Miller the true lac tree, of which I was favoured with a branch by himself, from the Chelsea garden, was found to contain, in its bark, and in the pedicles and ribs of the leaves, a somewhat milky juice, which soon changed in the air to a reddish brown, and in two or three hours to a deep blackish, or brownish-black colour; wherever the bark was cut or wounded, the incision became blackish; and on several parts of the leaves, the juice had spontaneously exuded, and stained them of the same colour. This juice, dropped on linen, gave at first little or no colour, looking only like a spot of oil; but by degrees the part moistened with it darkened in the same manner as the juice itself. On washing and boiling the linen with soap, the stain not only was not discharged, but seemed to have its blackness improved; as if a brown matter, with which the black was manifestly debased, had been in part washed out, so as to leave the black more pure.

It were to be wished that some attempts were made for collecting the colouring juices of these trees in sufficient plenty for answering the important purposes to which they promise to be applicable. Perhaps, also, means might be found of introducing into some parts of the extensive dominions of Great Britain, in which all varieties of soil and climate are now to be met with, the oriental trees themselves, to which some of the Indian manufactures are supposed to owe distinguished advantages. This there is now some grounds to hope for, from the patronage of a society,* whose encouragement has already so greatly promoted the culture of many valuable plants and trees.

As the milky juices of some of our common plants turn dark-coloured, or blackish in drying, I was induced to make trial of several of them on linen. The milks of wild poppies, garden poppies, dandelion, hawkweed, and sow-thistle, gave brown or brownish-red stains, which were discharged by washing with soap: the milks of the fig-tree, of lettuces, and of different kinds of spurges, gave no colour at all. The colourless juice which issues from hop-stalks when cut, stains linen of a pale reddish, or brownish-red, *extremely durable.* I tried to deepen the colour by repeated applications of the juice, but could never make any approach to blackness. The juice of sloes gave likewise a pale brownish stain, which, by repeated washings with soap, and wetting with a strong solution of alcaline salt, was darkened to a deeper brown. On baking the sloes, their juice turns red, and the red stain which it then imparts to linen is, on washing with soap, changed to a pale blueish, which also proves durable. The juices, both of the raw and baked sloes, were applied repeatedly on the same spots, in order to deepen their respective colours; and the brown or reddish-brown stain of the raw sloe, and the blue of the baked, were applied upon one another, on principles hereafter explained. In all these ways, a stain was obtained, which, when slightly washed with soap, looked of a pretty deep black; but by longer washing, much of the colour was discharged, and little more was left than a single application of the juice would have produced. The sloes were tried in different states of maturity, from the beginning of September to the middle of December, and the event was always nearly the same. Though these experiments, with many others of the same kind, proved unsuccessful, in regard to the production of the colour here intended; they serve to point out means which may be convenient and useful on some occasions, of marking linen with a colour, pale indeed, but sufficiently visible, and which soap does not discharge.

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* The Society for the Encouragement of Arts, Manufactures, and Commerce.

In the fifth volume of the celebrated Linnæus's *Amœnitates Academicæ,* mention is made of a black colour obtained from the berries of two plants, which grow wild in some of the northern parts of England, and which I have not hitherto had an opportunity of trying. One is the *actæa spicata*, or *christophoriana*, herb-christopher, or bane-berries; the other *empetrum procumbens*, or *erica baccifera nigra*, black-berried heath, crow-berries, or crake-berries. The juice of the bane-berries, boiled with alum, is said to yield a black ink; and the heath-berries, boiled also with alum, to dye cloths of a deep purple-black.

Cuttle Fish Ink.—The cuttle fish, said to be pretty common in the Mediterranean, is not wholly a stranger to our own seas, as appears from its bone being frequently found on our shores. This bone is hard on one side, but soft and yielding on the other, so as readily to receive pretty neat impressions from medals, &c., and afterwards to serve as a mould for the casting of metals, which thus take the figure of the original.* The bone is frequently employed likewise for polishing and cleaning silver. Mr. Borlase, in his Natural History of Cornwall, says that these bones, whose characters are so obvious and so singular that they cannot be mistaken, are found frequently on the shores of Mount's Bay; and likewise gives a description of the fish itself, as caught there on the sands in 1756. Dr. Leigh, also, in his Natural History of Lancashire and Cheshire, relates that he has seen the fish several times on the shores of those counties.

This fish contains, in a certain distinct vessel, a fluid as black as ink, which it is said to shed on being pursued, and thus to conceal itself by discolouring the water. The particular qualities of this black animal liquor I have had no opportunity of examining myself, nor have I been able to obtain any satisfactory information concerning them from others. Dr. Leigh, in the place before referred to, says he saw a letter which had been written with it ten years before, and which still continued: it were to be wished he had specified more particularly the continuance of the colour, whether in its full deepness, or much faded. Some report that the ancients made their ink from it, and others that it is the basis of the Indian or China ink. Both these accounts appear, however, from some experiments and observations, which will be related in the sequel of this article, to have little foundation. Pliny, speaking of the inks used in his time, after observing that the cuttle fish is, in this respect, of a wonderful nature, adds expressly, that ink was not made of it.

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* It is much better, however, to reduce the cuttle-fish bone to powder, and use it as loam or sand is employed in founding.—Editor.

SECTION III.

Black produced by Fire.—The action of fire, properly applied, in the burning of animal and vegetable substances, produces, in the coal and in the soot, the two most useful and durable blacks of the painter and the varnish-maker. The coal, in particular, is of extreme permanence, resisting the force of time, and all the known agents of nature, except only that of an open fire, which burns it into white ashes. Some bodies of the metallic kind assume, also, in certain circumstances, a black colour from fire.

Charcoal Blacks.—Most of the blacks of this class, besides their incorruptibility, have the advantage of a full colour, and work freely in all the forms in which powdery pigments are applied, provided they have been carefully prepared, by thoroughly burning the subject in a close vessel, and afterwards grinding the coal into a powder of due fineness.

Pieces of charcoal are used also in their entire state, for tracing the outlines of drawings, &c., in which intention they have an excellence, that their mark is easily wiped out. For these purposes, either the finer pieces of common charcoal are picked out and cut to a proper shape; or the pencils are formed of wood, and afterwards burnt into charcoal in a crucible, or other like vessel, covered and luted. When the process is skilfully managed, the coal retains the figure of the wood; some have been so dexterous as to char an arrow, without altering the form even of the feather.

The artists commonly make choice of the smaller branches of the tree, freed from the bark and pith, and some particular kinds of wood, as the willow and the vine, they generally prefer to others*. To discover the foundation of this preference, and how far the coals of different vegetables differ from one another as colouring materials, I made the following experiments:—

Small branches of the willow, vine, cherry, apple, pear, peach, plum, fig, birch, oak, elder, alder, yew, sloe, hazel, fir, and pine trees, were thoroughly dried and enclosed in a mass of luting, made of clay beaten up with sand and horse-dung: the mass, dried slowly, and gradually heated, to prevent its cracking, was kept red hot about three hours. On carefully breaking it, the pieces were all found well charred; but it could not be observed that they differed greatly from one another, either in colour, or in the freedom of their marking upon paper.

The experiment affording little decisive, I repeated the operation in crucibles, with greater quantities of the materials, that a more exact comparison might be made of the colour of the coals, by using them as paints, both in a concentrated and diluted state. Two crucibles were filled with vine twigs cut into small bits, freed from the knots, and thoroughly dried: the mouth of one crucible being then fitted into that of another, the juncture was well secured with luting. Small smooth branches of most of the other kinds of trees above mentioned, were in like manner inclosed, each in two crucibles, and all of them continued about four hours in a strong red heat. Cuttings of white paper, beaten with water into a paste, such as is called *papier maché*, that they might take up less room in the crucibles, and have less air lodged in their insterstices, were dried and treated in the same manner; but some flame appearing to burst out through a small crack which the vapour had forced in the luting, it was necessary to take out these crucibles, after they had been about ten minutes in a red heat; the paper, nevertheless, was perfectly charred.

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* The Editor finds that the charcoal made from even the *planks* of the horse-chesnut tree is preferable to any other for the use of artists.

The several coals were levigated into fine powder, mixed both with gum-water and oil, and applied as paints, both thin and thick, by themselves, and diluted with different proportions of white. All of them, when laid on thick, appeared of a strong full black; it could not be judged that one was of a finer colour than another. When spread thin, or diluted, there were indeed some sensible differences between them; but neither very considerable, nor of such a kind as to be easily expressed or described: they had all somewhat of a blueish cast, but different persons to whom the comparisons were referred, differed in their judgments of them, and could not fix on any particular coals as being more blueish, more truly black, or more beautiful than the rest.

Instead of the small branches, I tried next pieces of different woods, taken from the trunks of the trees. Here also the several coals appeared alike among themselves, and scarcely different in point of colour from those of the twigs, but they seemed in general somewhat harder, and did not mark quite so freely on paper, when used as crayons. Suspecting from hence, that the hardness of the coal might be proportioned to that of the subject it was prepared from, I made some further trials, which seemed to confirm this opinion. The coals of the hard woods, box and guaiacum, were very sensibly harder than those of the soft ones. The shells and stones of fruits yielded coals still harder, which would scarcely make any mark on paper at all; while the coals of the kernels of fruits were quite soft and mellow.

It may be judged, from these experiments, that the preference of one kind of wood to another, for making charcoal crayons, does not depend so much upon any difference of colour in the coals, as on their softness; in which quality, perhaps, none of our common woods is equal to the willow.* Dr. Grew observes, in his anatomy of plants, that, in this wood, the softness is equal or alike in all parts; whence the coal, when used as a crayon in painting, not only makes the stroke light, but every where certain, without disturbing the even motion of the hand. Deal or fir is likewise a very soft wood, but of unequal softness; so that, when cut across, it tears, and will never polish or work smooth; whereas the willow works well in all directions.

Horns, and the bones both of fishes and of land animals, gave coals rather more glossy and deeper coloured than the vegetable coals, and were, in general, very hard, so as difficultly, or not all, to stain paper. It seemed here, as in vegetables, that the hardness of the coal depends on that of the subject matter; for silk, wool, leather, blood, and the fleshy parts of animals, yielded soft coals. Some of these coals differed from others very sensibly in degree of colour: that of ivory is superior to the rest, and is indisputably the finest of all the charcoal blacks. Indeed, we have no black pigments equal in beauty to ivory black, genuinely prepared; but some care is repuisite in the choice of it; what is generally sold under this name being no other than the coal of common bones.

On comparing the vegetable and animal coals together, in their lighter shades, on paper, the blueish cast, observed in all those of the vegetable kingdom, was much less conspicuous in those of the animal, many of which seemed to incline rather to brown than to blue. In the colour shops a preparation is sold, under the name of *blue-black*, which, in this respect, differs from the animal, and agrees with the vegetable coals; seeming to have no greater a degree of blueness than the coals of the woods and twigs above-mentioned; and even than common charcoal. That this preparation is no other than a vegetable coal, appeared from the following experiment: laid on a red-hot iron it burned and glowed like powdered charcoal, and turned into white ashes; which ashes, thrown into oil of vitriol (sulphuric acid), very readily dissolved into a bitterish liquor, the characteristic by which the vegetable earth is distinguished. From what particular vegetable matter this blue-black is prepared experiments cannot discover; but those already mentioned seem sufficient to show that it may be obtained from many, and that the choice of the vegetable subject affects rather the softness or hardness than the colour of the coal.

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* See the preceding note.

After examining the different substances of the vegetable and animal kingdoms I tried a mineral body—pit-coal, of which several pieces, of different sorts, were charred in close crucibles. The charred coals, reduced into fine powder, and used as paints on paper, showed nothing of the brownish hue which the unburnt pit-coal had, when tried in the same manner; all of them inclining to blueish, and most of them having this cast in a greater degree than any of the vegetable coals. The blue-black of the shops cannot, however, be of this origin, the ashes of the charred pit-coal not being dissoluble by the vitriolic acid as those of the blue-black were found to be.

Soot Blacks.—The soot blacks are generally much softer and of a more yielding texture than those of the charcoal kind, and require much less grinding for uniting them with oily, watery, or spirituous liquors, into a smooth mass; of some of them a part is dissolved by water or spirit of wine, while none of the charcoal blacks have been found to contain any thing dissoluble.

This soluble matter of soot is not, however, black, like the indissoluble parts; and in this particular, as well as in the colour of the entire mass, different sorts of soot differ from one another. Thus the soot of pit-coal collected in common chimneys (of itself rather greyish-black than of a full black), being infused separately in rectified spirits of wine and in water, tinged the former of a transparent reddish colour, and the latter of a paler reddish; while the deeper black soot of wood both to spirit and water gave an opaque dark brown.

From the watery infusion of wood-soot is prepared the brown pigment called *bistre*, for painting in water-colours. According to M. Landois, in the French *encyclopedie*, the soot is either boiled in water, or ground with a little urine (water will do as well) into a smooth paste, and then diluted with more water: after standing for about half an hour, till the grosser substance of the soot has settled, the liquor is poured off into another vessel, and set by for two or three days, that the finer parts may fall to the bottom, which fine matter is the bistre. That the bistre of our colour shops has been prepared by a process of this kind, and not, as some have suspected, by exaporating the infusion of soot to an extract, may be presumed both from its appearance and its qualities. It is in little masses, such as are obtained in the common way of drying precipitates, or earthy powders that have been ground with water, by dropping them upon a chalk-stone. It readily mingles with water, and continues for a time uniformly diffused through the fluid: a considerable part was observed to settle in an hour or two, a part more slowly, and, after standing for many weeks, a part remained dissolved in the water, so as to tinge it of a brownish yellow colour, like a weak infusion of soot: this tinged liquor passed through a filtre without any separation of the colouring matter. In the preparation of the bistre, when the soot liquor has deposited all that will settle, the sediment, however drained, will necessarily retain some of the coloured fluid, which, drying, will leave in it some of the truly dissoluble parts of the soot; and hence, probably, proceeds the matter in bistre which we find to continue dissolved in water, the proportion of which is inconsiderable compared to that which precipitates. Different parcels of bistre differ considerably in their colour, on account, probably, of the different qualities of the soots which they were made from.*

The finest of the soot blacks, and the only one commonly made use of as a black pigment, is that called lamp-black, which is brought chiefly from Germany and Sweden. Its preparation is described in the Swedish transactions for the year 1754, as a process dependent on the making of common resin. The impure resinous juice, collected from incisions made in pine and fir-trees, is boiled down, with a little water, and strained, whilst hot, through a bag: the dregs and pieces of bark, left in the strainer, are burnt in a low oven, from which the smoke is conveyed, through a long passage, into a square chamber, having an opening in the top, on which is fastened a large sack, made of sleasy or thin-woven woollen stuff: the soot, or lamp-black, concretes partly in the chamber, from which it is swept out once in two or three days; and partly in the sack, which is now and then gently struck upon, both for shaking down the soot, and for clearing the interstices between thethreads, so as to produce a sufficient draught of air through it. Considerable quantities of this soot are prepared also in some parts of England, particularly at the turpentine-houses, from the dregs and refuse parts of the resinous matters which are there manufactured.

The soot arising in common chimneys, from the more oily and resinous woods, as the fir and pine, is observed to contain more dissoluble matter than that from other woods; and this dissoluble matter appears, in the former, to be more of an oily or resinous nature than in the latter; spirit of wine extracting it plentifully from the one, and water from the other. The oiliness and solubility of the soot seeming, therefore, to depend on those of the subject it is made from; it has ben thought that lamp-black must possess those qualities in a greater degree than any kind of common soot. Nevertheless, on examing several parcels of lamp-black, procured from different shops, I could not find that it gave any tincture at all, either to spirit or water.

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* The soot which collects on the walls, door, &c. of the stoves in which the bushel-makers expose their wooden bushel and other measures, to be browned by the smoke produced from burnt oak saw-dust, is highly esteemed by the colour-makers for making bistre with.—EDITOR.

Suspecting some mistake, or sophistication, or that the lamp-black had been burned or charred, as it sometimes is, to fit it for some particular uses, I prepared myself some soot from linseed oil by hanging a large copper pan over the flame of a lamp to receive its smoke. In this method the morecurious artists prepare lamp-black for the nicer purposes, and from this collection of it, from the flame of a lamp, this pigment probably received its name. The soot so prepared gave no tincture either to water or spirit, any more than the common lamp-black of the shops. I tried different kinds of oily and resinous bodies with the same event: even the soots obtained from fish oil and tallow did not appear to differ from those of the vegetable oils and resins. They were all of a finer colour than the lamp-black commonly sold.

Some soot was collected, in like manner, from fir and other woods, by burning small pieces of them slowly under a copper pan. All the soots were of a deeper black colour than those obtained from the same kinds of wood in a common chimney, and very little, if at all, inferior to those of the oils; they gave only a just discernible tincture to water and spirit, while the soots of the chimney imparted a strong deep one to both. The soot of mineral bitumens, in this close way of burning, appears to be of the same qualities with those of woods, oils, and resins. In some parts of Germany, as I am informed by a worthy foreign correspondent, great quantities of good lamp-black are prepared from the soot of pit-coal.

It appears, therefore, that the differences of soot do not depend altogether on the qualities of the subjects, but, in great measure, on the manner in which the subject is burnt or the soot caught. The soot produced in common chimneys, from different kinds of wood, resinous and not resinous, dry and green, do not differ near so much from one another as those which are produced from one kind of wood, in a common chimney, and in the more confined way of burning above-mentioned.

(To be continued.)

XIII.—*On Burning Anthracite, or Stone-coal, in open Fire-places. By Mr.* THOMAS, D. MITCHELL, *and Dr.* THOMAS P. JONES.

Frankford, January 9, 1826.

A PAPER was lately published in the *Franklin Journal,* and republished in our *Technical Repository,* Vol. IX. page 239, on the use of stone-coal, for the purposes of cookery, with a design of establishing the fact, that anthracite may be thus employed very advantageously, in a common fire-place, and without the aid of a blower.

The experiments performed by Mr. Vaux were made in April, 1825, and his full success has been reported by a committee of the Franklin Institute.

I do not intend to detract in the least from the credit due to Mr. Vaux, but think it right to state that a grate very similar to his was in full operation in my house, during the whole of last winter. It was more simple, however, than that of Mr. V.'s, and the one which I now have in use, (put up in August, 1825), is still less complicated. In place of the marble or soap-stone top, I employ sheet-iron, because it affords, by reason of its superior conducting power, a more extended surface for the operation of cookery. In lieu of an iron-plate partition, for the purpose of making a small fire occasionally, I have a slip grate, which by being raised or lowered, lessens or augments the receptacle of coal at pleasure.

But the principle of all this simplification was established even anteriorly to the construction of my first grate in

September, 1825; and it was the observance of this principle, in an apparatus presently to be noticed, that led to the formation of the simple grate first used in my kitchen. Every one almost has seen, and may have purchased, the summer furnaces for burning charcoal, which were originally of a semi-circular shape in the upper two thirds, the lower third remaining round. These have been denominated the *half-moon furnaces*, and are always coated with sheet-iron. Those who understand the management of Lehigh coal, can, with ease, kindle a good fire in the half-moon furnace, by first igniting some charcoal, dry oak, or hickory, and then throwing on the stone-coal, in pieces of about the size of an egg. In a common fire-place, or in the open air, a furnace of this kind may be used for burning Lehigh coal, unaided by any thing in the shape of a blower. During the whole of last summer, a furnace of the above description, with one of the round furnaces, served my family for all the purposes of domestic economy, in which fire was requisite, and the stone-coal was burnt in both, though to most advantage in the half-moon furnace.

I have been well satisfied for more than a year, that Lehigh coal can be burnt with far less trouble than many persons imagine, and agree fully with Mr. Vaux, that it would be more generally preferred for cooking, if its advantages were better understood. A trial fire made in my grate (noticed in the former part of this statement), at ten o'clock A. M., for the purpose of roasting, will burn well, undisturbed, until from six to eight in the evening, and then nearly a third of the coal will remain. What sort of wood fire can be kept up for so long a time, with so little trouble?

I should have added, that my grate will hold, probably, a peck and a half of stone-coal.

THOMAS D. MITCHELL.

Remarks on Anthracite. By Dr. THOMAS P. JONES, *Editor of the Franklin Journal.*

We were much gratified by the preceding communication from Mr. Mitchell; for although the fact has been long known to us, that anthracite might be burned without that great draught, and those other special preparations, which are generally deemed requisite, yet experience has taught us, that the publication of one or two experiments, however satisfactory, or however well authenticated they may be, will go but little way in removing strong prejudices. Mr. Vaux did not, in his communication, pretend to have made a new discovery, but only to give a clear and striking exemplification of a fact, which, although known to some persons, was contrary to the general belief. The committe of the Franklin Institute, who reported upon the experiments of Mr. Vaux, were well aware of what had been previously done in this city (Philadelphia) and elsewhere; and carefully avoided the giving a higher degree of credit to that gentleman than they believed to be merited by the industry with which he prosecuted, and the success with which he performed his experiments.

The editor of the Miner's Journal had stated, nearly two years since, that " a chimney with the worst draught possible will do for burning anthracite, perhaps better than one with a quick draught; for the fire burns more steadily, and of course the heat is more equal. If there be an aperture sufficiently large to carry off the small quantity of gas disengaged in the combustion of stone-coal, it is all that is required.

"I have seen a fire of stone-coal burning delightfully in an open grate, in a large open kitchen fire-place, within which half-a-dozen people might stand around the fire, and the chimney of which smoked to such a degree with a wood fire, that it was almost impossible to stay in the room." In the same paper many other facts had been stated, proving the facility and economy with which anthracite might be used, for almost every purpose for which fuel is necessary. These facts are *confirmed* by the experience of Mr. Vaux and of others; and during the last summer, several of our citizens burned stone coal in the open air, using the ordinary earthen furnaces. There are now a number of kitchens in which the whole of the cooking is satisfactorily performed with stone coal, in open grates. Mr. Thomas Hughes, Mr. John Moss, and several other gentlemen, have also perpetual ovens, which are heated by the fires in their grates, and which most completely answer the intended purpose. Mr. Joseph Truman has lately constructed a fire-place in his kitchen, which promises to answer well. The grate is of the usual form; there is, upon that part of the hearth which is immediately under it, a grating which allows the ashes to fall into a receptacle in the cellar, whilst it admits an abundant draught of air to support the combustion, and which may be regulated by a valve. The jambs are built with brick, and in each there is a round hole left, in the form of a chaffing-dish, or furnace, with draught-holes, and doors, both of which may be used at pleasure, as they are independent of the grate.

Such is the facility with which the stone coal is now managed in its combustion, that many persons are already at a loss to discover wherein consisted those difficulties which were encountered in the first attempts to use it; and we believe that the time will soon arrive, when our servants will, if required to use wood for cooking fires, object to it, on account of the *difficulty* in managing it! In London, where bituminous coal is the only fuel, the whole corps of cooks would rise in open rebellion, were they required to substitute wood in their operations; and we think that our stone coal is as much to be preferred to the bituminous kind, in all the operations of the kitchen, as our servants now think wood is preferable to anthracite.

Novel as is the use of stone coal in the city of Philadelphia, it has been employed for upwards of fifty years in some parts of the state of Pennsylvania. "Judge Gore, of Wilkes-barre, first used anthracite, or the Wilkes-barre coal, in his blacksmith's shop, about the year 1770; and no other coal has been generally used in the Wyoming Valley since that period. Judge Fell first introduced the *grate* for burning anthracite about eighteen years since. It was substantially the same as that now used for common domestic purposes, and has received very little improvement, other than ornament." Were it necessary to exemplify the tardiness with which we learn and profit by the example set by our immediate neighbours, when our domestic habits are concerned, the facts above stated would be sufficient for the purpose.

A very injurious practice is generally pursued in the setting of our grates. This may be collected from some of the preceding remarks, but it is a point of so much importance as to merit a more particular notice. We allude to the strong draught which is given, as is evinced in the furnace-like roar of our fire-places. The effect of this is, to burn out the fuel with great rapidity, and to send a large portion of the heat up the chimney. Many of our workmen, having once adopted this plan, will pertinaciously adhere to it; and it will be necessary for those who are to pay for the coal, and sit by the fires, to inform themselves on this subject, and to insist upon having the work performed in such a way as shall promote economy and comfort.

Many intelligent engineers have expressed an opinion, that anthracite would never be found to answer well in the fire-places of steam-engine boilers. We are, however, informed, that at the Phœnix nail-works stone coal has been used for many months, and that it is preferred to every other kind of fuel; the fire-place, we believe, was not constructed with a view to the employment of stone coal; but a little practice has served to prove, that the difficulties anticipated in the use of it were imaginary. It would indeed be strange, if a fuel so readily burned, and giving out an intense heat, should be incapable of having its heat combined with water, so as to convert it into steam.

Additional Remarks, by the EDITOR *of the Technological Repository, on the Employment of Anthracite as Fuel.*

We rejoice that the prejudices of the citizens of Philadelphia, and those of the inhabitants of other parts of the United States, against the employment of anthracite as fuel, are beginning to be overcome, and trust that its value will shortly become more and more evident.

It is surely high time that the attention of our fellow-countrymen should be directed to the use of this valuable fuel, in a far greater degree than has hitherto taken place. Its chief employment has been confined to the making of malt, and other purposes, for which its want of bitumen, and consequently burning without yielding smoke, rendered it peculiarly eligible. But it now appears that it is equally adapted to cooking, and all other purposes of domestic economy.

It is true that patents have been taken out here by Messrs. Christie and Harper, for the employment of the anthracite mixed with bituminous coal, as fuel, in the year 1823, one of which will be found in vol. v. of our *Technical Repository*, page 73; and we have continually, in that work, insisted on the propriety of employing our immense beds of anthracite in Wales, and other parts of the United Kingdom, in a much more extensive way than has hitherto been the case. We now trust that this will soon happen, encouraged as we are by the success of our trans-atlantic rivals in the use of it; and we would recommend, in the case of steam-engine boilers, that the waste steam be employed to excite its energy, in the judicious manner indicated by Mr. Evans, formerly of Bread-street-hill, but now residing in Queen-street, Cheapside, in using gas-coke as fuel, and as described in the *Technical Repository*, vol. viii. p. 94, and we can then entertain no doubt of its complete success; indeed, a friend of ours did, at our suggestion, make a partial trial of its efficacy in the case of the anthracite, as we there stated, but his experiments were not continued for any great length of time.

XIV.—*On making Inking-rollers, as a substitute for Balls in Printing. By* DR. THOMAS P. JONES, *Editor of the Franklin Journal.*

ELASTIC composition inking-rollers have been substituted for balls, at a great number of presses in Philadelphia. Every innovation of this kind, whatever may be its intrinsic worth, has to struggle into use, over the strong prejudices which are engendered by long continued habit. The old printing-press preserved its form and its structure, nearly unchanged, for ages; and although it is now universally confessed, that this instrument, in consequence of the changes it has recently undergone, affords one of the most striking examples of the successful application of mechanical ingenuity, not only executing the work more perfectly than the old press, but greatly abridging the labour of the pressman, this triumph was not gained without a severe struggle.

Some of our best printers are already convinced, that work can be done better with the roller than with the ball; and it is evident that the labour is much lessened by its use; among the journeymen, however, there is much contrariety of opinion, and habit gives to them a strong bias in favour of the old practice; yet, judging from what we have seen, we think that the roller stands a fair chance of fighting its way into favour.

The rollers have not yet been made here, with that truth which is necessary to their perfect operation; they ought to be cylinders; but if the circle were not absolutely perfect, this defect would be less important, than any deviation from a straight line, lengthwise; the roller reaches across the whole form, and should touch the faces of the types with an equable force; for although it is elastic, this elasticity will not compensate for any sensible deviation from straightness in the roller.

To attain the necessary degree of perfection in the form of the roller, it is requisite that the mould in which it is cast, should be correctly made, and that it be of a material which will retain its form, and to which the composition will not adhere. Most of those which have been used here, have been made of wood; and had good close-grained mahogany been taken, it would have answered the purpose very well, after filling the grain with some resinous composition: there is scarcely any other kind of wood, equally hard and close grained, which is so little apt to cast as mahogany; the workmen, however, have tried inferior species of wood, and have consequently failed. An ingenious mechanic of this city undertook to make moulds of brass; of these he cast several pair; they were semi-cylinders, about three feet in length, three inches in diameter, and ¼ inch in thickness; in the casting, he succeeded remarkably well; and in order to bore them out, they were soft-soldered together, and firmly clamped; one pair was bored, but upon separating them, it was found that they had sprung in both directions, so that when put together, they formed an oval instead of a circle, and would not come close on the edges. The editor was consulted as to the cause of this springing, and the means of preventing it; but in this, as in many other cases, it was more easy to discover the cause of the evil, than to apply a remedy. In boring brass, the angle of the cutter must be very obtuse; and whilst it cuts, it also acts as a burnisher, closing the pores of the metal and stretching the surface which it abrades. The thickness of the cast moulds was not sufficient to resist the effect of this stretching, and they consequently sprung open; the result was, that they were abandoned, as it was thought that the labour of finishing them in any other way would exceed their value.]

It now became desirable to devise some easy method of forming moulds for immediate use. The editor suggested the employment of plaster of Paris; he has not yet heard how this has succeeded, but, if properly managed, it cannot fail to answer the purpose.

The manner of casting plaster moulds is known to a great number of workmen; we cannot, on the present occasion, enter into any detail upon this subject, but will do so at an early period.

For the purpose of casting a cylinder, the mould ought to be divided into three segments, as it is then readily separated from the article cast in it, which is not the case when it consists of two segments only.

Plaster moulds of the length required for inking rollers, ought to be made nearly two inches in thickness; they may be strengthened by passing stiff rods of iron lengthwise through the middle of each section. After the plaster is cast, four or five days will be required to dry it perfectly: it may then be saturated with a composition of linseed oil and bees'-wax, or of linseed oil and resin. The plaster must be merely warmed, as if heated too highly it will be rendered rotten. Where time is allowed, boiled linseed oil alone is the best article for saturating plaster moulds: successive coats are then to be laid on, until it is no longer absorbed; the moulds may be then exposed to the action of the sun, or kept in a warm place, until the oil is dry. This will give to them a dark brownish yellow colour, a smooth surface, and a texture resembling earthenware; in this state there is little danger of their chipping, or being otherwise defaced.

In order to form the plaster mould, a cylinder of wood must be turned, of the diameter of the intended roller, and several inches more in length. The composition of which the rollers are made, contracts in length very considerably, after being cast, before it becomes set; for this, allowance must of course be made in the length of the moulds.

XV.—*On gaining Land from the Sea.* *By* JOHN HARRIOT, *Esq.*[*]

SIR, *Rochford, Sept.* 15, 1785.

IN May, 1781, I purchased an island, called Rushley, situate between Great Wakering, in Essex, and Foulness island, containing two hundred and sixteen acres of land, which was covered by the sea every flood tide, but left dry on the ebb. About the middle of June I began to enclose the same, by raising a bank of earth, thirty feet wide at bottom, seven feet high, and four feet wide at top, giving the advantage of the batter, or slope, full two for one on the outside; that is, every foot in height was drawn in two feet; by this means the violence of the waves is so much abated, that instead of beating, shaking, and tearing the banks, which is the case with all that I have seen, they spend their fury in a gentle curl up the slope of the bank.

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[*] From Vol. IV. of the Transactions of the Society for the encouragement of Arts, Manufacturers, and Commerce. The society voted the premium of heir gold medal to Mr. Harriot.

I had from twenty to thirty people constantly at work upon this bank, until the following Christmas; at which time I had completed my bank, containing six hundred and forty rods in length, twenty-one feet to the rod: the bank running in the circular form of the island, the extreme ends were brought opposite each other. There was a large deep'rill, seventy feet wide, and twenty feet deep, through which the tide (now confined by the bank) poured in and out with a fall like that at London Bridge; to get across this rill, and shut the tide out, was to be the ultimatum of all my hopes and fears; and it may be supposed they were not a little agitated, as the greatest part of my little property was at stake, and the whole neighbourhood had deemed it impracticable.

On Christmas day an attempt was made (with earth only) to close the breach up, which proved ineffectual, for the next tide carried it all away. My spirits raised with my difficulties; I immediately determined on another plan, and procured long piles, or rather timber trees, and when framed ready, drove them (by the help of an engine) in two rows across the rill, leaving a space of fifteen feet between the rows, and six inches between the piles. I then laid a tier of strong girders across, about four feet from the bottom, and another about three feet from the top of the piles; the height of the piles, when drove into the ground, being fourteen feet. When this was completed, taking the advantage of the lowest of the neap tides, I filled this cam, or hutch, with earth in one tide; and which, when filled, became one strong compact body, so that no one part could give way without the whole yielding.

I raised the earth just high enough to prevent the tide overflowing it, and before the next tide came I had strengthened the cam by stowing earth on each side, and raising the top: this I continued doing until I had extended the foot one hundred feet towards the sea, and fifty feet withinside, raising the top gradually all the time, until I had attained the same height (or rather higher) as the bank, making it seven feet wide at top.

By this plan, on the 17th of January, following my Christmas miscarriage, I effectually shut the tide out from one hundred and forty-two acres of rich arable land; and by the same means, am enabled to graze the seventy-four acres of saltings withoutside the bank. The purchase of the island was forty pounds, including which, with my expences of embanking, &c. the whole amount of my gaining this land from the sea was only five hundred and seventy pounds: since that it has cost me about fifty pounds more in raising particular parts of the bank that settled more than the rest.

I have likewise built a house, a barn, and a stable on the island, where my bailiff and family, with two or three labourers, constantly reside.

The land, for the first two years, was so very poachy and wet, that it was with much difficulty I was able to stir any of it; but by perseverance, I have now one hundred and twenty acres of it, in as good tillage as any turnip land, seventy acres of which is now sown with rape seed for a crop next year: the other fifty I sow next spring, some with mustard seed, and some with oats. I find the salts are too powerful in the land, as yet, for wheat; but from what little rape or mustard seed I grew this last year, I find it suits either of them exceedingly well; and I hope next year's crop will not only save me from the predictions of many of my neighbours, viz. my ruin, but begin to repay me with interest; for so confident am I of the richness and goodness of the soil, that (unless necessity should compel me to it) I would not let it for forty shillings per acre; and had I the command of a few of those spare thousands which many gentlemen seem at a loss what to do with, I make no doubt but in a few years I could enlarge his Majesty's dominions, by a great increase of rich landed property to individuals.

And am, sir,
Your most obedient and very humble servant,
To S. MORE, *Esq. Sec.* J. HARRIOT.

The Committee of Agriculture, having taken the foregoing account into their consideration, directed a letter to be written to Mr. Harriot, desiring him to inform the committee, whence the water of the rill therein mentioned arises? what provision is made for the discharging any superfluous water from the land? and how the cattle are to be supplied with fresh water? In answer to which queries the following letter was received.

SIR, *Rochford, Nov.* 25, 1785.

I this day received your much esteemed favour of the 22d instant, advising that the Committee of Agriculture wished to be informed whence the water of the rill, mentioned in my former account, arises? what provision is made for discharging any superfluous water from the land? and how the cattle are provided with fresh water? To the first, I have to observe, that previous to my beginning to embank, the whole island was intersected with several very large rills, which, as they communicated with each other, divided the land into so many irregular marshes or fields, yet they had but three inlets or outlets, through which the tide constantly ebbed and flowed, covering the whole surface of the island long before high water. Time, and the continual action of such ebbing and flowing, made those rills equal to the receiving and discharging the tide, so fast as it ebbed or flowed; but long before I could finish my bank, I found it necessary to stop the two smaller inlets, which I easily effected whilst the tide ebbed and flowed so gently; but after this, when the tide had but one inlet, and the bank was nearly completed, it formed so large a reservoir, that the tide could neither come in nor go out fast enough to keep the water on a level, which of course caused a great fall both ebb and flood. When I first began my bank or wall, I did not propose stopping either of the inlets until the last of all, but I soon found myself obliged to stop two of them, in order to prevent the water having a thoroughfare, which began to damage the inside of my bank. After they were stopped, the water within did no further damage, its effect and violence being directed to one point: and when at the last I shut the tide entirely out, by filling up that only remaining large rill or inlet, as described in my former letter, there remained no other cause for superfluous water, except the draining of the wet land, and what fell from the heavens; for which I had at the beginning prepared and laid a drain or gutter, made of elm, eighteen inches wide, twelve inches deep, and fifty feet in length, with proper lids or doors at each end, to let the water in or out at pleasure: this gutter lies three feet and a half lower than the surface of the earth. And here I beg leave to observe a great mistake that is found in most gutters that I have seen; in general they are made square, or nearly so; yet there is no comparison in the discharge of water from a flat gutter, of the same number of square inches, with a square gutter.

I wish it were in my power to give the gentlemen of the committee a better account of my success, in endeavouring to provide good fresh water for my cattle. It is now two years since I made a pond, twenty-five feet wide, forty feet long, and three feet deep from the surface; all the earth that came out I formed into a sloping bank round the pond, to enlarge the surface for catching rain, &c. by which means (and the first winter when there was a great fall of snow, I set my men to casting of snow into it) I have several times filled it, and as often have had to empty it, for although it is fresh at first, it soon gets brackish. The bottom is a blueish leaden-coloured firm loam, and holds water like a china bowl*; yet I am of opinion it is the oozing of the salts from the bottom, that continues to make the water so brackish, and unfit for use, that I am for the most part obliged to fetch my water in casks, except in rainy weather, when the troughs round my buildings supply me pretty well. However, I am in some hopes that the ensuing winter may wash away and exhaust the remaining salts about the sides and bottom of the pond; if not, and next year's crop proves, as I have every reason, from present appearances, to expect it may, I intend being at the expence of first claying the bottom and sides, then lay flat square bricks in terras, and over that a layer of chalk, beat fine, which I should think may prove effectual.

Be pleased, sir, to present my best respects to the gentlemen of the committee, and acquaint them, my heart exhults in the thought, that my labour may not be unworthy their notice; and next to their approbation, they cannot give me a more sensible pleasure, than pointing out (by their questions, &c.) how I may add my mite of information for public utility, either by personal attendance, or in such humble inditing as I am capable of.

I am, with great respect, sir,
Your much obliged and very humble servant,
J. HARRIOT.

To S. Moore, Esq. Sec.

LIST OF PATENTS FOR NEW INVENTIONS,

Which have passed the Great Seal since May 26, 1827.

To William John Hobson Hood, of Arundel Street, Strand, in the county of Middlesex, lieut. in our royal navy; for certain improvements on Pumps, or Machinery for raising or forcing Water, chiefly applicable to Ships. Dated May 26, 1827.—In six months.

To George Burges, of Bagnigge Wells, in the county of Middlesex, Gent; for certain improvements in the construction of Wheeled Carriages, and of Wheels to be attached to the said Carriages, or for other purposes. Dated May 26, 1827.—In six months.

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* This would have been a favourable situation for boring for water in the present improved mode.—EDITOR.

To Thomas Clarke, of Market Harborough, in the county of Leicester, carpet and worsted-manufacturer; for certain improvements in manufacturing Carpets. Dated May 27, 1827.—In four months.

To Malcom Muir, of the city of Glasgow; for certain Machinery for preparing Boards for Flooring, and other similar purposes. Dated June 1, 1827.—In two months.

To John Were Clarke, of Tiverton, in the county of Devon; for an improved mode of attaching, fixing, or securing the Dead-Eyes to the Channels, and sides of Ships or Vessels. Dated June 8, 1827.—In six months.

To Joseph Clisild Daniell, of Stoke, in thecounty of Wilts, clothier; for certain improvements in preparing Wire Cards, and dressing Woollen and other Cloths. Dated June 8, 1827.—In six months.

To Charles Phillips, Esq. of Rochester, in the county of Kent, a captain in our royal navy; for certain improvements on Capstans. Dated June 8, 1827.—In six months.

To Hugh Evans, of Great Surrey Street, in the county of Surrey, a lieutenant in our royal marine corps; and William Robert Wale King, of No, 66, Snow Hill, in the City of London, tin-plate worker; for a new Table Apparatus, to promote the ease, comfort, and economy of persons at sea, or on nautical excursions. Dated June 12, 1827.—In six months.

To Thomas Don, of No. 9, Lower James Street, Golden Square, in the parish of St. James, in the City of Westminster, mill-wright; and Andrew Smith, of No. 28, Wells Street, Oxford Street, in the parish of Marylebone, in the county of Middlesex, builder; for methods of making and constructing Shutters and Blinds, of iron or steel, or any other metals, or composition thereof; and improved methods of constructing and fixing Shutters and Blinds of iron or steel, or any other metals or materials; and methods of uniting in Shutters the double properties of Shutters and Blinds. Dated June 16, 1827.—In two months.

To Solomon Robinson, of Leeds, in the county of York, flax dresser; for improvements in Machinery for hackling or dressing and clearing hemp, flax, and tow. Dated June 16, 1827.—In six months.

To Lambert Dexter, of King's Arms Yard, Coleman Street, in the City of London, Esq.; who, in consequence of a communication made to him by a certain foreigner residing abroad, is in possession of an invention of certain improvements in Machinery, for the purpose of spinning wool, cotton, and other fibrous substances, Dated June 16, 1827.—In six months.

GILL'S

TECHNOLOGICAL REPOSITORY.

XVI.—*On Splitting, Cutting, and Polishing Diamonds, and on forming, mounting, and using Engravers', Glaziers', and Writing Diamonds, Diamond Dust, &c. By Mr.* EDMUND TURRELL, *Engraver.*

WITH A PLATE.

(*Continued from p.* 18.)

I HAVE stated, in the early part of this article*, that the diamond is found in a crystalized form, and also in rolled pieces. Those rolled pieces that are too small for the purposes of cutting, and also those crystallized stones which are of a bad colour, and are consequently unfit to be used as polished stones, are selected for sale, under the technical name of *bort*. This is the article which is now become so exceedingly useful in the hands of glass-cutters and glaziers, seal-engravers, dentists, copper-plate engravers, lapidaries, china-menders, engravers for calico-printers, hard steel-turners, and engravers on that metal in every state of hardness and temper. It is also used for dividing on hard steel and glass, for micrometers, and has been very successfully employed in constructing an adjustable draw-plate, for giving the most perfect equality to pendulum spring wire, for chronometers, by my most scientific friend Mr. William Hardy †.

On Glass-cutters' and Glaziers' Diamonds.—Many other valuable objects are also effected from the extraordinary hardness of the diamond; there are, as I have before stated, many purposes to which diamonds in the rough, technically termed *bort*, are applied; one of the most important is, the employment of the stones, in their natural state, in the art of cutting or separating glass.

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* Page 3.

† Whose celebrated time-keepers are frequently referred to in our *Technical Repository.*—EDITOR.

The process or method of cutting glass is well known; but the peculiar action of the diamond has attracted the attention of some of the first philosophers of the age. I believe I cannot do better than to extract Dr. Wollaston's ideas upon the subject, as communicated by him to the Royal Society*.

He says, "When we consider how long the diamond has been in common use, for the purpose of cutting glass, it is rather surprising that no adequate explanation has been given of that remarkable property, and that even the conditions on which the effect depends have not been duly investigated.

"Many persons, indeed, are not aware of the distinction that is to be drawn between *scratching* and *cutting*. In the former, the surface of the glass is torn into a rough furrow; in the latter, a small fissure or superficial crack is made, which should be continued without interruption from one end to the other of the line in which the glass is intended to be cut. The skilful workman then applies a small force solely at one extremity of this line, and the crack which he forms is led by the fissure, almost with certainty, to the other.

"Any other substance, harder than glass, possesses the power of *scratching*, in common with the diamond. But the power of *cutting* has been thought confined to the diamond; and it is true that its peculiar hardness certainly contributes to the duration of that power.

"I was informed that persons employed in setting diamonds for the use of the glazier always select natural diamonds, distinctly crystallized, which they term sparks; but upon what circumstance this supposed superiority of the natural diamond, over that which has been cut by art, could depend, I was not able to gain any information.

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* See the Society's Transactions.

"Having procured a common glazier's diamond ready set, and such a quantity of glass as I thought would be sufficient for learning by experiment the art of cutting, I endeavoured first, by forcible pressure on the point, in different directions, to effect my purpose. But, although I could thus tear the surface to a considerable depth, I could by no means command the direction of the fracture.

"When I placed the diamond more inclined to the surface, I could occasionally, and in part, obtain what I thought to be a proper cut; but I was unable to continue the stroke with steadiness, and so incapable of repeating it a second time, with a similar effect, that I was convinced the precise direction necessary for cutting was confined within very narrow limits.

"Having found that the diamond required to be moved in the direction of one of its edges, and having, by repeated trials, formed a judgment of the requisite inclination of its handle, I mounted it in a frame, in which I could fix it at any angle of elevation that appeared suitable, and could turn it round its axis, to adjust the direction of its edge. By this arrangement I had no difficulty in repeating my successful trial, or of varying it according to hints derive from such imperfections as were observable; and I soon discovered that difference in the form of the natural diamond, from that of diamonds formed by art, on which I believe the powers of cutting to depend.

"When a diamond is formed and polished by the lapidary, all the surfaces are plane surfaces, as far as it is in his power to make them so; and, consequently, the edge or line in which they meet is straight. But in the natural diamond there is this peculiarity in those modifications of its crystals that are chosen for this purpose, that the faces in general are all curved; and, consequently, the meeting of any two of them presents a curvilinear edge. If the diamond be so placed that the line of the intended cut is a tangent to this edge, near to its extremity; and if the two surfaces of the diamond, laterally adjacent, be equally inclined to the surface of the glass, then the conditions necessary for effecting the cut are complied with.

" The curvature, however, of the edge is not considerable, and, consequently, the limits of inclination are very confined; for if the handle be either too much or too little elevated, then one or other extremity of the curve will be made to bear angularly upon the glass, and will plough a ragged groove by pressure upon its point. But, on the contrary, when the contact is duly formed, a simple fissure is effected, as if by lateral pressure of the adjacent surfaces of the diamond directed equally to each side. By that means adjacent portions at the surface of the glass are forced asunder farther than the mere elasticity of the parts beneath will allow, and a partial separation or superficial crack is produced. The effects of inequality of the lateral inclination of the faces of the diamond to the surface of the glass are different, according to the degree of inequality. If the difference be very small, the cut may still be clear; but, as the fissure is then not at right angles to the surface, the subsequent fracture is found inclined accordingly. But when an attempt is made to cut, with an inclination that deviated still more from the perpendicular, the glass is found superficially flawed out on that side to which the greater pressure was directed, and the cut completely fails.

" It might be thought that the weakness of the glass in this part would, nevertheless, occasion it to break in the desired direction; but the bottom of a flaw is, in fact, of very great breadth when compared to the simple crack produced in a proper cut. In one case, the force applied to break the glass is dispersed over a space of some extent, and may be diverted from its course; in the other, the whole force is confined successively to the mere points of a mathematical line, which may be considered the bottom of the fissure, and is directed onward by the facility with which the adhesion of each particle, in succession, yields to its progress.

" The depth to which the fissure made by the diamond penetrates, need not be greater than 1-20th of an inch; for I found that the fracture might be completely turned from its course at any part of the intended line, by grinding away a portion of the surface ; and, by an average of several experiments, the thickness of the glass was not found to be diminished so much as 6-1000ths of an inch.

" Since the form of the cutting edge appeared, from the above trials, to be the principal circumstance on which the property of cutting depends, I thought it not improbable, that other stones, possessed of the requisite hardness, might be found to produce the same effect, if brought to a similar curvilinear edge. By a little pains, I succeeded in giving this form to a *sapphire*, a *ruby*, a *spinel-ruby*, to *rock-crystal*, and some other substances, and found that each of these bodies has the power of cutting glass, for a short time, with a clean fissure. But, notwithstanding the hardness of the ruby was such as to occasion a great deal of labour in the giving it the form I wished, the edge of this stone was by no means proportionally lasting. I am inclined to ascribe this defect, in part, to the grain, or position of laminæ, having been unluckily oblique. And it seems highly probable, that the singular durability of the diamond is owing, in some measure, to this circumstance, that its hardness, in the direction of the natural angle of the crystal, is greater than in any other direction, as we find to be the case in other crystals, of which the various degrees of hardness, in different directions, can be more easily examined."

There can be no reason to doubt the truth of Dr. Wollaston's remarks, upon the superior hardness of the external laminæ, or skin of the diamond, in its natural crystallized state; for diamond-cutters are so well aware of this circumstance, that they never begin to polish a diamond, however favourable the plane of a crystal may be, without abrading that plane against another diamond, in order to remove the external surface. It is this extreme degree of hardness that makes the natural diamond so peculiarly fit for the purpose of cutting glass; and also of indenting extremely fine lines on the surface of glass, where microscopic divisions are requisite.

I have remarked, that, in all cases, the diamond that cuts glass most successfully, will be found to have the cutting edges of the crystal placed exactly at right-angles to each other, and passing exactly through a point of intersection, made by the crossing of the edges. In this case, it appears to be that portion of one of the edges, which is extremely near the point of intersection, that cuts, and scarcely any other. This assertion I make from experience; and the examination of a good cutting diamond will prove the fact.

In order the better to elucidate this interesting part of my subject, I have annexed figures of a diamond, drawn upon a large scale, posited agreeably to the above conditions; fig. 1, of plate III., being a side and end elevation, and fig. 2 a plan of it.

In these figures A B represent the leading curved part of the cutting edge of the diamond; and D, in fig. 1, and C D, the line of intersection, crossing the line A B at right angles; E being the following part of the cutting edge. The general figure of the stone is farther indicated in all the figures by dotted lines; and its position, in a hole, formed in the metal block F, in which it is first adjusted, and afterwards secured by hard solder, is likewise shown.

Fig. 3 is a side view; fig. 4 a front view; and fig. 5 an end view of a glazier's diamond, mounted with a swivel-adjüstment for the block F, when connected with the handle G, by means of the screw H, entering into a gap filed half way through, and across the metal stem I. By this means, the cut of the diamond is much easier obtained, than when, as usual, the diamond is mounted firmly into its stem; the swivel permitting the block to ply freely, and keeping the cutting edge of the diamond parallel with the edge of the straight rule, or other shaped pattern, it is carried along, and thus removing the difficulty of finding its due position, and leaving the workman the task of merely attending to the proper inclination of the handle, as to whether it is carried more or less upright for instance, or leaning to the one or the other side, to suit the cut, and which a very little practice will soon ascertain.

I shall here add another fact, in illustration of this part of my subject; and which, as it is familiar to most persons, will be readily understood.

Glass is frequently divided in a given direction or line, for instance, by winding a thread drawn through melted sulphur, around a bottle or matrass, at the part where it is wished to separate it, and then setting the sulphur on fire, when the glass will be found to crack in the exact direction of the thread. It it evident that this effect takes place from a very minute portion of the glass being suddenly expanded by the heat, and thus acting as a sort of wedge, it splits, and thereby divides the glass in the direction of the given line.

The watch-glass makers roughly separate their glasses, and which are segments of spheres, from the entire sphere or bulb, by merely laying a finished glass on the sphere, as a pattern, and then carrying around the edge of the pattern the red-hot stem of a tobacco-pipe; and by then giving the sphere a slight tap or blow, at the part thus heated, the glass drops out from the sphere completely separated.

Some persons with whom I have conversed wished to attribute the action of the cutting-diamond upon glass to electricity. But, in my opinion, it simply acts at first as a burnisher, which compresses a few particles of glass, and then immediately produces the effect of a number of infinitely small wedges, as it were, driven into the glass; and the consequence is, that the glass naturally separates, in the direction of the line, in which the diamond was carried.

Mr. Baker, in his work on the microscope, states, as a beautiful proof of the exquisite finish bestowed by nature upon her productions, that if we examine the claws, at the extremities of the feet of the minutest insect, we shall find, that although they are nearly invisible to the naked eye, yet, when submitted to the investigating powers of the highest magnifiers, they appear to have the most exquisite polish upon their surfaces. Whereas, the most perfect work of art, however high its gloss may be, sinks into insignificance, when submitted to such a test and examination. I have been led into these observations by a circumstance well worthy of attention:—

If minute divisions, for microscopic purposes, are attempted to be made upon a glass, with the edge of a cut and polished diamond, however perfect it may be, it instantly splinters up the surface of the glass, even with the lightest pressure; a sure proof, that, whatever its appearance may be, yet that it is unfit for the purpose, owing to the roughness of its edge. Whereas, when the natural diamond is used, whose surface has not been disturbed by the processes of the workman, we find that the most beautiful lines may be made, and whose surfaces are so finely burnished, that when ruled sufficiently close together, they will decompose the coloured rays of light, and afford the most beautiful prismatic appearances. This is evidently an effect, produced by the most perfect degree of smoothness, or polish, and which is only to be found on the surface of the natural diamond.

Mr. Barton, of the Royal Mint, has thus produced some very extraordinary specimens of dividing, upon hardened and polished steel plates, even of 2,000 lines in one inch, with the natural diamond; and I have also divided some excellent specimens upon crown-glass, with a similar diamond.

As a farther elucidation of the methods of cutting and polishing diamonds, described in the beginning of this article, I have added, in fig. 6, a section, showing the manner of affixing, by means of cement, the diamonds to the wooden handles, for the purpose of abrading or cutting them; and in fig. 7, another section of the copper cup or *dop*, J, with its copper wire stem K, by which it is held in the tongs (shown in plate I.); L is the fusible metal, and M the diamond, partly imbedded in the fusible metal, and partly projecting out of it, with its face resting upon the skive N, in the act of being polished.

(*To be continued.*)

XVII.—*On improving the Colours of Agates, and on an improved manner of using Florence Oil Flasks. By Mr.* J. LUKENS, *Engineer.*

THERE are certain parts of agates which have the property of imbibing oil, and other fluids, in a similar manner with the Turkey oil-stone. Mr. Lukens being applied to by a lapidary in the United States, to learn whether the colours of the common agates might not be heightened, so as to resemble some beautiful specimens he produced, availed himself of the above property, and accordingly caused several of the German agates to imbibe oil, by steeping them in it for two or three hours; he then wiped their surfaces clean from the oil, and placed them in sulphuric acid, which he put into a Florence oil flask, and heated over a charcoal fire, until sulphurous acid fumes were extricated in abundance. He then, after suffering the whole to cool, and washing off the acid with water, found that the agates had partially imbibed the oil, and that the sulphuric acid in its turn penetrating them, by carbonizing the oil, had considerably deepened the colour of those parts so impregnated with oil, had rendered the veins more white and opaque, and had thereby *very greatly increased the beauty, and consequently the value of the stones.*

Mr. Lukens has kindly repeated this experiment before us, and has likewise given us permission to make his process known to the public; and it may also be desirable to describe his very simple and convenient apparatus used on the occasion.

Instead of converting the Florence oil flask into a capsule, as usual, he perforates the side of it with an oval hole, large enough for the introduction of the agates, thus leaving the neck of the flask to serve as a very convenient handle to lift and carry it by.

He perforatas the flask by heating a part of it with a hot iron, and wetting it until a flaw is made, which, by means of the heated iron, he leads around in a proper direction to form the hole.

His furnace consisted of a small garden pot, about five inches deep, and four wide, and placed upon a larger pot inverted; the hole in the bottom of the smaller pot being placed over that in the centre of the bottom of the larger one. He had also perforated the side of the small pot in several places, with holes of three quarters of an inch in diameter, by holding it against a drill held and turned in his lathe. This pot he partly filled with charcoal, and then laying upon the charcoal a few fine wood shavings, and kindling them by means of an oxiginated match, dipped into sulphuric acid, he laid more charcoal upon the kindled shavings, and, by the help of bellows, quickly ignited the whole mass of charcoal. A thin metal plate, having a circular hole of three inches in diameter in its centre, and laid upon the top of the garden pot, thus converted into a furnace, supported the Florence flask and its contents in a very convenient manner.

We like to record these cheap, very simple, and useful expedients, as they may serve to show how easily a chemical apparatus, necessary in a great variety of operations, may be formed, even of the commonest vessels, in the hands of a scientific individual; and the whole cost of the apparatus would not probably exceed sixpence!

XVIII.—*On hardening small Chronometer Balance-Springs bright, or without discolouring them. By Mr.* J. LUKENS, *Engineer.*

WE have, at present, merely to announce this important process to our readers; expecting, hereafter, to be permitted by Mr. Lukens to disclose the manner of effecting it.

Having witnessed the whole process, we can judge of its complete efficacy, and the admirable simplicity with which Mr. Lukens conducts it.

The helical springs may be hardened either in their collapsed or extended states, and their cylindrical figure is completely preserved; so that they only require to be blued in the usual manner, by placing them upon a brass cylinder, and directing the flame of a lamp or candle, urged by the blow-pipe, to either end of the cylinder alternately, until the colour is obtained to fit them for use: the usual troublesome process, of polishing them after hardening, being unnecessary.

The qualities of the steel are preserved in the most perfect manner; and, indeed, the strength and elasticity of the spring seems greatly increased by the process. The grain of the steel, when broken in the hardened state, being also peculiarly close and fine.

We have no doubt that this valuable process will be found applicable to other small articles also.

XIX.—*On a superior mode of communicating Magnetism; and also on a method of quickly removing it from Magnets. By Mr.* J. LUKENS, *Engineer.*

THE particulars of this communication must also, for the present, and for especial reasons, be withheld. We, however, hope to be permitted to lay the processes as fully before our readers, as Mr. Lukens has already kindly done, for our own gratification.

Suffice it to say, that he has very greatly improved *the touch*, as it is usually termed, and can quickly, and with certainty, communicate a powerful magnetic influence to bar or horse-shoe magnets; and also effectually remove the compound horse-shoe magnet, employed to magnetise them, without impairing their virtue in the least degree; a circumstance of the utmost consequence, as it not unfrequently happens that a failure in this particular shall render nugatory all the previous labour.

Mr. Lukens can, however, as readily weaken the magnets as he can strengthen their powers; in short, he seems to possess the entire control over the magnetic influence, directing it at his pleasure.

XX.—*On an improved Diamond Plough, or Beam-Compass, for Cutting Circular Lines upon Glass. Invented by Mr.* J. LUKENS, *Engineer,* U. S.

WITH A FIGURE.

IN plate III., fig. 8 is a perspective view or elevation of such parts of this useful instrument as are necessary for understanding its construction, shown of their real size. O O is part of a square bar of brass, ten inches long, and graduated into half-inches as radii, and answering to inches of the diameters of the circles, to be drawn with the instrument, and these half-inches are again subdivided into parts, and regularly numbered. Upon this bar the sliding centre P moves, and can be secured at any required situation by its binding screw, Q; R is a cylindrical part, affixed firmly upon one end of the bar, and having a conical hole made through it, in a vertical direction, to receive the tapering socket of a glazier's cutting diamond, S, within it, and which can be retained in a proper direction, when the cut of the diamond is found by trial, by the binding screw T; U is a brass-wire, firmly affixed into the cylinder R, having its foot, V, rounded, and turned up at its end. This foot is carried evenly along, in contact with the surface of the glass to be cut, and regulates the inclination of the diamond, as must be likewise found by trial, and bending the wire U more or less, until the proper degree is ascertained. The other, or opposite end of the bar, O O, is terminated by a brass ball affixed upon it, and the point P of the sliding centre is supported by and turns in a small conical hole made in a plate of metal, the back of which is coated with a thin layer of bees'-wax, which, upon being pressed into contact with the surface of the glass to be cut, readily adheres to it, with a degree of firmness quite sufficient for the purpose.

This instrument cuts incisions more or less deep in the glass, according to the goodness of the diamond, and the skill with which it is adjusted and managed. However, Mr. Lukens states that he can cause even a slight cut to penetrate through a thick plate of glass, by alternately placing it in warm and cold water; the contraction and expansion thus produced effecting the separation of the glass.

We trust that this very convenient though simple instrument will soon come into general use amongst us.

XXI.—*On an improved Pump-Drill and Guiding-Frame. By the* EDITOR.

WITH A FIGURE.

ON examining a valuable collection of native Chinese drawings, of workmen exercising their various trades, the Editor was much surprised to find that the pump-drills, used in a great variety of instances, had their weights, or metal balls constantly placed at the tops, instead of being near the bottoms of the stems, as employed here; and thus leaving to the workman a full view of the work doing by the drill, instead of impeding that view.

Upon mentioning this circumstance to Mr. H. W. Revely, to whom our volumes of the *Technical Repository* are so much indebted for several important communication, he mentioned that the same practice took place in Italy; and farther, that a *guiding-frame* was also used to steady the upper end of the stem of the drill with great advantage.

In plate III., fig. 9 is a representation of such a pump-drill and frame. The situation of its ball or weight near the lower part of the stem is indicated by the dotted line, and its elevated one is shown in its place. The guiding-frame is composed of a base and two cylindrical pillars, upon which a cross-bar is made to slide up and down, and to be retained at any required height by two binding-screws. In order to ascertain the exact position of the hole in the body to be drilled, so that it shall be central to the guiding hole of the upper part of the stem of the drill, the cross-bar should be lowered down to it, and a slender cylinder of steel, shown in fig. 10, made to fit the socket in the cross-bar, and having a sharp conical point, be placed in the socket, and be caused to enter the mark or place where the intended hole is to be drilled. The exact position of the body to be drilled being thus ascertained, the steel cylinder must be withdrawn from the socket, and the cross-bar raised to a proper height to receive the upper part of the stem of the drill within it, as shown in fig. 9, when it will be fit for use in a great number of instances, with far greater convenience and accuracy than the common pump-drill.

Our figure shows a Lariviere's half-round drill as being fixed in the stock; but such a *hollow drill stock* as we have described in the 2d vol. of the *Technical Repository,* p. 147, as being invented by the late Mr. William Allen, and used by him in his business of a tortoise-shell and ivory worker, is far more convenient for holding drills made of steel wire of various sizes, so necessary in that line of work; and such drill-stocks are well deserving of being manufactured and sold in our Lancashire tool shops, in preference to the ordinary ones.

XXII.—*On a difficult Test Object for the Microscope. By the* EDITOR.

WITH A FIGURE.

ON the Editor calling upon Mr. Dollond, the celebrated optician, lately, he mentioned that he shortly expected to be furnished with *a difficult test object* for his microscope, by Mr. Carpenter, a great admirer of that useful instrument, and an entomologist also. On this the Editor went to that gentleman for information on this subject, when he told him that it was the exceedingly curious and minute hairs, found upon the exuviæ of the larva of a dermestes, and which the Editor had formerly pointed out to his notice, that he had mentioned to Mr. Dollond.

This, together with another fact, convinced the Editor, that this beautiful object was by no means so well known as it deserves to be. He was with Mr. Cuthbert lately examining the powers of his small Amici's reflecting microscope, and had brought this object with him for trial amongst others. It was quite new to Mr. Cuthbert, and, which was very singular, he had actually put up a larva of this dermestes, amongst other objects, in the sliders of a microscope he was making for their mutual friend Mr. Cooper, the celebrated lecturer on chemisty applied to the arts, without even suspecting the presence of these minute hairs; a clear proof that the Varley's single microscope, in the possession of the Editor, and the construction of which, with two plates of figures illustrating it, he has given in his ninth volume of the *Technical Repository*, and by the use of which he has discovered *these difficult test objects*, was by no means an imperfect instrument, but the very reverse thereof, as Mr. Cuthbert had failed in discovering them with his microscope.

In plate III., fig. 11, V represents one of the larger compound hairs, well known to exist in the exuviæ of the larva of the dermestes; and W, several of *the still more* *minute and curious ones* above mentioned, as viewed by a single lens of 1-30th of an inch focus.

One would naturally feel surprised at the exquisite beauty of finish bestowed by nature, on these, to us, comparatively insignificant objects; and which indeed can only be seen by the microscopic eyes of insects, or by persons possessed of excellent microscopes! The general construction of the hairs much resembles that of the down of the feathers of several birds, as the red-breast, the linnet, &c., but the extraordinary care bestowed upon the elegant terminations of the hairs is indeed wonderful and unique!

XXIII.—*On Purifying Coal Gas. By Mr.* WILLIAM MATTHEWS.

13, *Anderson's Buildings, City Road,*
London, July 16, 1827.

SIR,

THE art of gas lighting having now become, in a great degree, a national concern, every effort to improve it may be considered as an endeavour to benefit the public. But circumstances may perhaps have given me a prediliction in its favour, as I happened to be one of those who had the pleasure of witnessing Mr. Murdock's splendid display at the Soho, near Birmingham, in 1802, and afterwards some of Mr. Winsor's exhibitions in London. As I then anticipated that its application would eventually be extensive, so I have attentively noticed its progressive advances, and have hailed, with no ordinary interest, every attempt, however trivial, that in the least degree conduced to its improvement.

At an early period of its use, the purification of coal gas was one of the chief difficulties that attended its processes; but these have long been obviated by the exertions of a few eminent and scientific men. I have seen an account of a process recently introduced at the Birmingham and Staffordshire gas works, on the principle of a patent lately obtained there; I sincerely hope that this improvement will prove to be *new.* But I presume you are aware that the purification of coal gas by ammoniacal gas has long been practised; for a patent for purifying coal gas upon this plan was taken out in 1817, by Mr. Daniel Wilson, of Dublin; and his specification, with a representation of his apparatus, will be found in vol. xxxii, p. 11, of the Repertory of Arts. Perhaps the new method of purifying is an improvement on Mr. Wilson's. It is stated in a late periodical work, that " Mr. B. Cook, of Birmingham, recommended the use of lime in 1810;" but I have no recollection of ever reading or hearing of such a circumstance before; and if it be a fact, it has escaped my observation. I have reason to believe that Mr. Murdoch purified coal gas with lime, in various ways, twenty-five years ago; and Dr. Henry notices the washing it with lime-water, in his paper, published in Nicholson's Journal for 1805. Where, however, ten tons of lime per day are used I am rather curious to learn; the Chartered Gas Works are on a larger scale than any other in the world; and no establishment being conducted with greater ability, the skilful superintendants of that very extensive concern must, I presume, have read, with not a little surprise, this account of the quantity of lime, as well as some other things in that paper. But I am disposed to suspect that the patentee has been deceived by his informants; for being acquainted with his character, I am confident he is too candid and honourable a man to publish, knowingly and intentionally, any exaggerated or erroneous statements. To excite attention to an important object, to correct mistakes, and, if possible, to obtain accurate information, are my only motives for writing the above remarks, and your insertion of them in your *Technological Repository* will oblige, sir,

Yours respecfully,

W. MATTHEWS.

To T. GILL, *Esq.*

XXIV.—*On a Novel Hypothesis, concerning the Influence of the Strata near the Surface of the Earth on the Atmosphere.* *By* W. A. MACKINNON, *Esq.* F. R. S.

A PAPER has been presented to the Royal Society, concerning the influence of limestone, chalk, and some other strata on the atmosphere, by William Alexander Mackinnon, Esq. F. R. S., in which this hypothesis is advanced; and the results are said to be, that the dryness or dampness of the air, and, consequently, the sprightliness and vivacity, or sedateness, not only of individuals, but even of a whole people, may depend more on the substrata than is commonly imagined. The following is the summary of the leading points:—

Mr. M. begins his paper by stating, that residing in the vicinity of Southampton, about seven miles from the great bed of chalk that runs through part of Hampshire and the neighbouring counties, he was struck with the difference of the air, when on the chalk, to what it was when going towards the New Forest, though both were equally distant from the water. That, in consequence, experiments were tried with hygrometers (De Luc's, of Whalebone, and Daniell's), and the result of these was, that, invariably, a greater degree of dryness was found in the atmosphere over the chalk, than over clay or alluvial substances. Mr. M. however adds, that the hygrometer is an instrument so very uncertain in its results, and so liable to inaccuracy, that little reliance ought to be placed on experiments made with it, unless confirmed by other observations. He says, however, that every subsequent observation confirms the hypothesis, that if chalk is laid on a field as a dressing, it will, at the end of some hours, become damp, even if no rain or but little dew has fallen, which dampness commonly arises from the atmosphere. Also, that turf grass, growing over chalk or limestone, even in the hottest summer, always looks green and healthy; which must, Mr. Mackinnon thinks, arise from the absorption of atmospheric moisture, by a sort of capillary attraction, from the chalk or limestone; which moisture, passing through the slight covering of mould, keeps the roots of the grass sufficiently moist to look green; whereas, the same heat burns up turf-grass over clay or alluvial substances, or gravel, in a remarkable degree. Mr. Mackinnon brings forward many other arguments in favour of this assertion; he says, that from this absorbing power, or capillary attraction of atmospheric damp, by certain strata, a house, built on a chalk foundation, or of chalk materials, will commonly be damp, and for the same reason if limestone or sea sand is used.

The paper further states, that if the dryness or dampness of the atmosphere is affected by the strata, that must also affect the spirits, or the health of the inhabitants; and even some other qualities of individuals or nations, may depend more on the substratum than is commonly imagined.

XXV.—*Questions Proposed for Solution, Heads of Minutes of the Conversation, and a List of Original Communications received in the Institution of Civil Engineers of London.*

We are indebted to William Rutt, Esq. the worthy secretary to the above excellent institution, for a copy of the circular lately issued amongst the members of that body. He, however, thinks it desirable, that a wider circulation should be given to it, in order that the public in general may be informed of the nature and objects of the institution, and to which desire we gladly lend our concurrence.

Institution of Civil Engineers, Buckingham Street, Adelphi,
SIR, *London, July* 1, 1827.

I am directed to forward to you a list of questions that have engaged the attention of the members of this institution during the past session; and to request that you will favour the society by whatever information you can communicate on them, it being the object of the institution to collect and to record information for the use of its members. Minutes of the conversation at each meeting have been taken, and are open to the inspection of the members: a list is subjoined. The institution has also received papers on various subjects, and which are also here enumerated.

As the discussion of questions connected with the objects of the institution forms an important feature in its proceedings, it is desirable that the different members should furnish a supply during the recess, in order that materials may be collected and arranged for discussion at the ensuing session, which commences on the second Tuesday in January, 1828.

I have the honour to be, sir,
Your most obedient and humble servant,
William Rutt, Secretary.

List of Questions.

1. What are the relative advantages in the employment of high pressure and low pressure steam, or which will produce the greatest effect with the same quantity of coals?

2. What is the comparative cost of conveyance by the various animal powers usually employed?

3. What is the comparative cost of conveyance by means of the common turnpike roads, in proportion to the different rates of motion?

4. What is the best means of shipping and unshipping common paddle-wheels of steam-boats, so as to make the breadth required for the passage of the vessel not more than the actual breadth of the vessel, some small quantity allowed for to effect the passage?

5. What is the cost of conveyance per ton per mile by steam boats on the east coast of England?

6. It is found necessary to employ charcoal in purifying

copper, in order to make it malleable; what is the proportion of the weight of charcoal employed to the weight of copper, and by what methods can it be ascertained, during the process of fusion, if the metal is properly purified, so as to be malleable when cold?

7. A great number of roofs have of late years been built either of cast iron, or of wrought, or of both; what is the best mode of using this material for roofs, the strength, the cost, and the durability considered?

8. What effect will the removal of London Bridge have upon the river Thames above bridge?

9. What are the laws which govern the motion of æriform fluids through pipes of various lengths and diameters, and subject to various degrees of pressure?

10. Why is the difference of time between high water at the Nore and at London Bridge only two hours, while the distance is forty miles, and the velocity of the current nowhere more than from three to four miles per hour?

11. What relation does the difference of the velocity of the top of the tide and of the velocity of the current bear to the proportional difference of the depth at high and low water?

12. Can any rule be laid down for approximately determining the depth of water from a given velocity of the top of the tide, a given velocity of the current, and a given rise of the tide?

13. A plan is discovered for heating conservatories, hothouses, &c., by means of hot water passing through horizontal pipes instead of steam, it being found that if two pipes proceed horizontally one above the other, from the side of any open boiler, below the surface of the water, and be either connected together, or terminate in a vessel of water at their extreme ends, a constant circulation of hot water will be kept up through the pipes so long as any fire be kept under the boiler. Query—What is the best form of boiler and proportional size, and perpendicular distance of pipes (regard being had to their length), to

produce a maximum effect in heating greenhouses, conservatories, &c., on the above plan?

14. What are the best curves for the water and other lines of steam-vessels in order to produce the greatest speed from a given power of steam-engine, propelling a given tonnage, and what the best mode of describing such curves on a large scale?

15. Have expanding metallic pistons, when applied to steam cylinders and pumps, produced beneficial results, and which of the various kinds invented is found to answer best in practice?

16. Have any of the alloys of steel with other metals made better edge tools than were before made, by using pure steel without any alloy?

17. What are the mechanical methods of ascertaining the velocities of wind and water?

18. What are the comparative merits of the various methods before the public of consuming or preventing smoke arising from steam engines and other large fires?

19. In the blasting of rocks what attention should be given to the direction of the bore, in order to the removal of the greatest quantity of material; and also what regard should be paid in boring to obtain blocks of the greatest magnitude?

Minutes of Conversation.

16. On the diving bell.

17. On unshipping paddle-wheels—Purifying copper.

18. On unshipping paddle-wheels—Purifying copper—High and low steam.

19. On cost of conveyance—Unshipping paddle-wheels—Removal of London Bridge.

20. On the removal of London Bridge—Paddle-wheels.

21. On a power from heat—Tides and London Bridge.

22. On tides.

23. On steam-engines—Passage of air through pipes.

24. On steam and steam-engines—Motion of boats

through water—London Bridge removal—Passage of air through pipes—Gas.

25. On light and heat—Steam-engines—Passage of air through pipes.

26. On heating greenhouses—Discharging shot.

27. On heating greenhouses—Curves for ships—Alloy of steel—Metallic pistons.

28. On blasting rocks—Heating buildings.

29. On metallic pistons—High and low steam.

30. On friction—Passing of air through pipes.

31. On currents in rivers—Machines for raising water from great depths—Diving bell.

32. On the velocity of wind and water—Instrument to ascertain the velocity of wind and water.

33. On blasting rocks—Smoke.

34. On the passing of gas through pipes, and measuring the quantity passed—Motion of vessels with the tide.

List of Original Communications.

1. On the expansion of water by heat.

2. Drawing and description of a new bridge.

3. Drawings and description of a plan for power by the agency of heat from flame.

4. A paper to account for the rapid movement of the tide from the Nore to London Bridge, with diagrams.

5. A paper on heating greenhouses, &c.

6. Specimens of curves for naval architecture, generated by continuous motion.

7. A paper on cementing steel with silver.

8. Drawings and description of Perkins's metallic piston.

9. A paper on blasting slate rock.

10. A paper on evaporating water.

11. Tables of comparison of French and English weights and measures.

XXVI.—*A description of the American Marine Railway, as constructed at New York, by Mr.* JOHN THOMAS, *Civil Engineer; with Explanations of its Principle, and Manifestations of its Safety for Ships of War. By* JOHN L. SULLIVAN, *Esq. Civil Engineer**.

TO THE FRANKLIN INSTITUTE OF THE STATE OF PENNSYLVANIA.

GENTLEMEN,

THE marine railway has become a subject of interest to the public, both as regards national and private economy. Public opinion, which your institution is calculated to enlighten, on subjects of mechanical philosophy, being founded in experience as well as principle, in testimony as well as practice, it cannot but be satisfactory, when one peculiarly qualified to bear witness, is brought thus before those who are so competent to judge.

The inventor of the American marine railway†, has not only the advantage of being a practical mechanic, but was brought up in in the best school of practice, the naval dock yards of Plymouth, in England, where he served also twenty years, as master shipwright; and perhaps no man in our own country has had an equal opportunity of forming a correct opinion, upon the comparative advantages of the marine railway, and the dry dock.

In thus inviting your strict investigation of his improvement, as arbiters between him and the American commercial interest, he comes before you with the uncommon advantage of not offering a mere project, however ingegenious, but of showing you a machine, greatly useful, reduced to practice, operating with perfect success, and producing ample profits.

In a national relation, it may be equally useful, because from Long Island to Pensacola the soil is alluvial; and it may be of consequence in public economy, to find an unexceptionable substitute for the dry dock.

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* From the *Franklin Journal* for February last.

† Termed in the patent, the *Railway Dock*.

If the old custom of heaving ships down be detrimental to our mercantile marine, built comparatively strong, how much more so must it not be to our ships of war, containing at least eight hundred joints, not one of which can safely bear to be strained.

The object of the railway dock is to take the ship, while afloat, and, before she loses the support of the water, to surround her with other supports, give her keel firm foundation, her bilge a cradle, and her bends a general and substantial shoring. Without the least change of figure from that she had in the water, she is taken out of it, and being put in complete order, is gently returned to her element.

If it were a question of comparative actual expense, between hauling up a frigate for a medium repair, requiring ninety days, or to place her for the same purpose in a dry dock, Mr. Thomas thinks, from his experience, that the following would be a fair calculation:—

	Dollars.
To haul up the frigate on the railway	15
To let her down	3
	18
To place a frigate in a dry dock	45
To undock her	17
Lobour, hoisting up and lowering down, old and new materials, ten men ninety days, at one dollar per day	900
Pumping dock three times a week at sixteen dollars	208
Loss of time for want of light in the dry dock, morning and evening	100
Dollars	1270

Saving each time, or in this ratio, 1252 dollars.

Besides this, the work is best done in the light and air, and an additional value is thus conferred on the whole ship.

A marine railway is indeed of easy device and construction, where the tide retires far enough to lay it down on the dry bottom, and where, as in Scotland, the object of it is to receive small or flat ships; but it is far different when sharp and large ships are to be safely received, and the greater part of the work to be under water. This is the case in all our ports in the middle and southern states, and such is the description of the American mercantile marine. Even many of our coasters are ships of three hundred tons.

An account of the origin of the first railway dock in our country, may be the most suitable preface to its description; and the public may yet owe much to the discernment and enterprise of a few of the largest shipowners at New York. These gentlemen*, knowing the disadvantage to themselves, and others, of heaving down ships, associated to apply for an act of incorporation to build a dry dock, rather than continue that practice. But as it was known to be a very difficult structure, especially as the rise of tide is there but five feet, and a coffer-dam would be necessary, it required a large capital to undertake it, and so incalculable was the expense, as to need the encouragement and protection of an annexed privilege, of so much value as to balance any possible loss. The legislature, composed of agriculturists, and of commercial men, were not slow to perceive the advantages of this public accommodation, nor the equity of guarding it as proposed.

The difficulty, as well as expense, of constructing a coffer-dam, and a recollection of Morton's marine railway in Scotland, had led Professor Renwick, of Columbia College, who had been consulted as a civil engineer, to advise the company to substitute that invention for the dry dock.

Knowing only that the company was deliberating on the best means of effectuating the purpose of their charter, I wrote to recommend Thomas's railway dock to their attention, and subsequently explained its principal features personally. Upon the representations made to them, the board of directors came to the resolution of building one, and immediately employed Mr. Thomas to construct a diving bell, and to make other preparations. But some of the proprietors were not fully satisfied; and a gentleman, going to England, was commissioned to visit Scotland, to see Morton's invention, and to collect more minute information upon the subject.

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* T. H. Smith, F. Thompson, and others.

On his report, the board again submitted the subject to the judgment of Professor Renwick; and, as the decision of a person so highly qualified will be a valuable testimonial before the institute and the public, especially as its candour bears honourable testimony to the integrity with which he has executed his trust, I shall presume to offer a quotation from his letter to the board of directors, dated the 10th of December, 1825. At page 9 of its printed copy he says:—

"A vessel, even of the largest size, will be much more free from risk of injury upon a railway, than in a dry dock. On the first, she may be completely shored and supported, before her original water-borne state is changed; in the last, the application of shores is a difficult and hazardous operation. This advantage, which is in some measure possessed by all railways, is much increased in that erecting for the company, by the improvements that Mr. Thomas has introduced in the form and structure of the carriage.

"And here I would state, that I entered upon the examination of that part of the subject with strong impressions against any alteration from the original plan of Morton; so much so, that I did not hesitate to condemn the works already constructed, merely in consequence of this deviation. In his inclined plane, the vessels are supported upon the carriage by wedges; and this method has been found sufficient for the vessels of that part of the world. These vessels, as I am well aware from personal examination, are very different in mould from our merchant ships, and still more different from our ships of war, and fast sailing craft. But even in the full built, and flat floored ships of the northern parts of Great Britain, it is evident that the process of re-launching cannot be performed, until all the wedges and shores aft of the midship frame shall have been removed; and in sharp vessels, both the aftermost and foremost sets of wedges will be found difficult of application, and to add little to the security of the vessel. Wedges also appear to be ill fitted to allow of the change of figure that takes place in all large vessels, when they pass from the state of floatation in water to that of resting upon their keels. Impressed with these difficulties, Mr. Thomas has proposed, and prepared to carry into effect, such a modification of the railway carriage, as shall permit the vessel to be supported by stays and shores, as when upon the stocks, instead of resting upon wedges; in this change I, after mature deliberation, fully concur with him."

While thus adducing such valuable testimonials as are calculated to satisfy the public (if the institute should so far approve of the improvement as to make their journal its introducer to the public eye), I should do the subject injustice, were I to omit to mention the good opinion, also, of the merchants of Philadelphia, decidedly and unanimously expressed by a committee of the chamber of commerce, whose attention was drawn, as it passed through the city, to a model of the railway, ordered by the honourable the secretary of the uavy to be made for the use of the department.

On this occasion, I ought not to omit the experimental confirmation of the judgment of Professor Renwick, soon after his opinion was pronounced. I allude to the fatal accident of the ship Panther, which fell over, and was wrecked, at Salem, on a Morton's rail-way. The wedges, being drawn under her bottom upon the cross timbers, could have no other support than those timbers; and should only one, two, or three of them, along midships, have taken the weight, and yielded, however little, the inclining pressure of the ship at the same time must be augmented by the leverage of all that part thereof overhanging the wedges, which are thus converted into fulcra, and the superincumbent weight to an active force. The danger that the cross timbers will break down, or the ship break in, and thus fall over, becomes imminent; and this accident actually happened, as above stated.

Of the Construction and Advantages of Thomas's Railway Dock.—The process of constructing the rail-way dock requires, first, the regulation of the bottom, if so shoal as to interfere with the intended slope of the work; or it may be excavated within the shore, with the proper slope, if a channel should prevent its extension.

The foundation piles are to be driven in four lines; the two inner rows near to each other, in order to support the keel; the two outer rows to come under the shores.

The distance between the piles will be determined by the size of the timbers which bear the iron rails.

The size of the timber will depend on the burthen of the largest ship which it is contemplated to haul up. Four feet apart, in the centre line, will be generally sufficient; in the side lines, eight feet.

Buffon's experiments appear to be the foundation of the practical rule for computing the transverse strength of timber; which rule is, after much elucidation, given by Dr. Robison, in his *System of Mechanical Philosophy*, vol. 1. According to this rule, a beam of oak, one foot square, propped every four feet, will bear, before breaking, 113 tons, and will not bend with 37 tons.

The piles to be cut off under water, must be cut in the exact inclination of the plane, and level with each other transversely. The necessity of previously marking every pile separately, on every side, in accordance with the intended inclination of the ways, led to the invention of instruments requisite to the occasion.

An aerial inclined plane, parallel to that intended to be established under water, is obtained, by first fixing a true level across the head of the rail-way, and denoting each station by a target, the staff of which is so much above the line of plane, as will bring the lower end of the aerial plane above water. Targets, having each a staff of the same length, being next applied, and nailed to the outer, and some few to the intermediate piles, will exactly indicate the aerial inclined plane; while the point of the staff attached to the pile will indicate a point on one side thereof, in the intended plane of the foundation.

The level and bevel is an instrument, by which to ascertain every other point on the sides of the pile that will be in the intended plane.

The diving bell may now be supposed to be brought over the pile, and as much of this as it will take in cut off, together with the target staff, still leaving its lower end. This cutting is repeated till the workmen arrive in the bell, to the bottom of the staff, which remains a little below the last rough cutting. The level and bevel is then set on; this consists of a base-board with a post arising from its centre, to support a plumb-line, playing in a comb-piece, having a centre notch, to determine when the base is level transversely; and as this base is at the same angle with its post that the intended plane is to a perpendicular line; and the base being equally thick, its under side also indicates a parallel plane; so that being secured in its place, the distance is measured by compasses, from the ascertained point to the base-board, and thence to every point in the circumference of the pile, that is also in the intended plane; thus marking it, with accuracy, for cutting. This operation being the same for each pile, it results, that every one must be truly in the intended inclined plane, ready to receive the frames of railway, which are floated over, and sunk down to their places; or a plank is first secured upon the heads of the piles, upon which the frames are successively slided down.

The iron rails will, in point of size, depend on the weight they are to bear. They must, of course, afford a sufficient base to prevent them from being indented into the wood by a heavy load. The two middle rails, and the rack-piece for the palls, are generally cast in one. But if the rails are to be of rolled iron, the rack will be separate. The palls prevent the ship from accidentally running back.

The pressure of the load will, in the merchant ships, be greater forward and aft than at midships, because they generally become a little hogged: provision, therefore, must be made for this contingency; and it will be safe to propose cases, in which the largest class of ships to be received, will bear all their weight on the first ten feet forward, and the last ten feet aft.

The weight of a ship is often, erroneously, stated to be as many tons as she measures tons. The fact is, that when loaded, she displaces a quantity of water that would precisely weigh her whole weight, cargo included; and as she generally carries as many tons as her measurement, she connot, when light, weigh as many tons as she measures. She weighs only as much as the water she then displaces, and this will be in accordance with her heavy or light materials, oak, pine, or cedar. Wherefore, for explanation, I shall suppose the positive weight of ships to be one-half of their nominal tonnage.

A ship of war will be received upon a railway carriage, with the precautions to be subsequently explained, and its weight distributed equally all over it, and the foundation. The tendency of all ships being to acquire some curvature of keel, it will generally be injudicious to straighten them on the dock, as they will resume their lines on being again put afloat, opening thereby the upper seams, or butts. To keep the ship, when taken out of the water, in precisely the same shape she has in it, the curve of the keel must be ascertained, and the keel-blocks be made to conform thereto.

To measure the curvature of the keel, we have devised an instrument, consisting simply of a bar, suspended at each end by a graduated chain. This bar being long enough to reach across the ship, is passed under, and across her centre, at every five or ten feet, when the graduations on the chains will show the difference of depth at every point of contact, from stem to stern. For merchantmen, this precaution will not be generally necessary.

A ship of five hundred tons measurement will exert a pressure of 250 tons; and we have supposed the whole of this may have to be borne by the two extremities of the carriage, or by ten feet at each end. The axles, therefore, are at the extremities put nearest to each other; but as steam-boats will bear heaviest in the middle, the axles must be near to each other in the centre also, for their support.

The axles will be two feet apart in the first ten feet. Five axles will have to bear 125 tons, or 25 tons each; the bearings and wheels 12½ tons. The axles of the New York dock are three inches diameter, and the square of the section is 7,071 inches. The bearings are close to the wheels, in which the axles are fixed.

The strength of the rail is deduced from the experiments of Rennie. By a very powerful lever, mounted for this purpose, he proved that a cube of one-fourth of an inch of cast-iron, would not be crushed till loaded with 10,000 lbs.; a square inch of iron, having sixteen times as much surface, will probably bear 160,000 lbs. or 70 tons. It is obvious that the wheel will not touch the whole inch, but the adjacent particles will sustain those in contact; and probably the length of the rail, supporting the supposed square on two sides, it will bear more than it would in sixteen separate squares of one-fourth of an inch. A rail of one inch, however, is too narrow to be favourable to the duration of the wheels.

The wheels are considered as columns, as every section under the axle may be computed in the same manner.

The bearing of the axle being near the wheel, and the middle being somewhat enlarged, it may be computed to be able to bear in proportion to its diameter; the manner of receiving the pressure being such as not to bend the axle.

The transverse strength of iron does not appear to have been experimentally ascertained on a large scale. Mr.

Rennie's trials were on bars, propped 2 feet 8 inches apart. But, from the analogy of experiments described in Robison, on other materials, which resulted in showing the transverse strength, when closely supported, to be greater than the stength lengthwise, as 575 is to 205; it will be safe to assume it to be double, in this position, to that of suspension. Now, as a bar of iron, one inch square, is estimated to support,

According to Emerson,	76,400 lb.
——— Robison,	76,000
——— Rennie,	74,821

The lowest of which is 74,821 lb. (33 tons): it follows, that 7,071 inches would support 529,059 lb.; and five axles 1,181 tons, calling the two bearings one, because not closely supported on both sides; and instead of assuming the above analogy for position, taking as the rule only the direct strength of the iron.

This excessive strength seems to show, that part of the material might be spared. But, in fact, the expense of this ample provision of strength amounts but to a small sum of money. The central axles of the New York dock weigh about one ton, and would together suspend 9,300 tons.

The friction of the axles should be relieved by the intervention of brass bearings, as usual in machinery; and as Mr. Rennie's experiments proved that a cube of brass, of one-fourth of an inch, would not crush till pressed upon with a weight of 10,300 lb., it is demonstrable that this metal would stand well in this situation.

The side axles will sometimes have a proportionate share of the ship's weight to sustain; though she will ordinarily be prevented from inclining to one side or the other, by the adjusting screw, placed at the angles of the shear shores; yet it is necessary to guard against the force of high winds, and the weight which a hogged ship may sometimes throw upon the centre shores, before she is eased down at midships by the screws, if intended to be straightened.

The carriage is combined in a very strong manner, though it appears to be rather a light structure for its purpose. In its construction, the implement called the dowelling-bit, as improved by Mr. Thomas, is of great and essential use.

The dowell, you will recollect, is a cylinder of some hard wood (generally lignum vitæ), which is one-half inscribed into one, the other half into the other timber, where a joint is to be made of their surfaces, and which the dowell prevents from moving, or sliding on each other. To make the sockets for its reception was heretofore so laborious an operation, that few dowells were used; but they are now applied very easily. The gouge and screw are Thomas's improvements*. An augur-hole, a little smaller than the screw of the bit, being first bored, the thread of the screw will cause the bit to advance, as fast as its chisel and gouge can conveniently cut; and thus the whole labour is confined to turning it.

This instrument now makes it easy to dowell the frames of a ship, the knees of the timbers, the water-ways to the beams, the thick stuff of the wales to each other; and, generally, to bind the ship by a solid connexion of wood. This instrument, thus improved, has, as I am informed, been adopted in all the navy yards of the United States.

By means of irons and the dowells, the cross-ties are secured to the cills in such a manner as to make it impossible that the carriage should spread; and by thus tying the sides to the centre, the cross-timbers convert the oblique force of the shores into vertical pressure; and care is taken, in every instance, that a wheel shall stand directly under the base of every shore.

The shear-shores have a form which gives them great stability in their places, and answers other purposes to be mentioned; they are based in hollow quoin-blocks, either of wood or iron, divided across the middle of the hollow by a partition, which serves to hinge the two legs of contiguous shears. There is thus a continuity of solid material from the side of the ship to the foundation, from the moment she ceases to float till she is high and dry.

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* These, and other particulars, will appear in the two plates which will accompany the sequel of this important article.—EDITOR.

The shear-shore screws will sometimes have the important office, when ships are old and tender, of taking a good share of the weight of the ship's side, and distributing it along the carriage side, taking it off from the floor timber-heads, futtocks, and beam-ends, where ships are most liable to be weak.

The bilge levers are levers of the second class. One end is lodged fixedly on the centre cill of the carriage, while the other end is hove up between the legs of the shear-shores, by a windlass placed within them. The moving end is guided in a groove of the prop, and sustained, when up to its contact with the bilge, by means of an iron pin passing through the cheeks of the prop.

The cradle thus formed by the bilge levers, it is evident, will fit every successive vessel equally well, and may be removed singly, and replaced, as the work proceeds. And, as they require to be hauled up with considerable force, nothing can be desired more convenient than these shears.

The common keel blocks are, of course, placed between the cross-ties, and are of such a height as to allow ample room for the shipwrights to work under the flat of the bottom, standing between and upon the cross-timbers. But the bottom of the keel will sometimes have to be repaired; to accomplish this end, the instrument called the lifting plane, has been devised. In the operation of this machine two wedges are forced on by percussion; blows from opposite sides being simultaneously given, with the combined strength of a considerable number of men, when the resistance renders it necessary.

(To be continued.)

XXVII.—*On the different Black Colours. By the late celebrated* William Lewis, *M. B. and F. R. S.*

(*Continued from p.* 50.)

Black metallic calces.—The mineral cobalt, roasted till its arsenical parts are dissipated, becomes black; and being then melted with carbonaceous fluxes, yields a regulus, which likewise assumes a black colour by calcination. The same regulus is obtained from the artificial zaffre, whose basis is the roasted cobalt, and which is employed for tinging glass blue; as also from the deep blue glass itself, called, when ground, by the painters, smalt, and by the laundresses powder-blue. The cobalt, more valuable for these important products than for the property which occasions it to be here taken notice of, and which has hitherto been afforded chiefly by Saxony, has, by the encouragement of the Society of Arts, been discovered in our own country: in further searches for it, the property here mentioned may be of great assistance; those minerals, and those only, which calcine black, promising to be useful cobalts. Calces of iron, whether red, yellow, or of other colours, on being brought into fusion by the addition of vitreous bodies, give always a black colour to the glass, if the quantity of iron is considerable. From copper also a black colour may be produced by fire, and applied to the staining and embellishing of certain stones, of which an account will be given hereafter, towards the end of this article. I have not observed that any of the other metallic bodies are changed black, in any circumstances, by simple heat.

SECTION IV.

Black produced by Mixture.

Black from Iron.—From infusions of certain vegetables, mixed with green vitriol (sulphate of iron), is produced a deep black liquor, of most extensive use for dying and staining black. To woollen and silk it gives a permanent colour;

although from linen, and other vegetable bodies, its blackness is discharged by washing.

The substances chiefly employed for producing the colour with vitriol, are the excrescences of the oak-tree, called galls, of which there are two principal kinds: one, said to be brought from the Levant, and the other from some of the southern parts of Europe, particularly Sicily and Romania. The former, called by authors Aleppo galls, and in the shops of our dry-salters, blue galls, are generally of a blueish colour, or of a greyish or blackish, verging to blueness, unequal and warty on the surface, hard to break, and of a close and compact texture; the others, commonly called white gallspale, are of a brownish or whitish colour; smooth, round, easily broken, less compact, and of a much larger size. The two sorts differ in strength, but in other respects they appear to be of the same quality. The Aleppo or blue galls are the strongest: two parts of these are reckoned by the workmen to be equivalent to three of the white; and such comparisons, as I have made of the two, incline me to think, that the difference in their strength, is rather grater than this proportion.

These excrescences appear to proceed from the juices of the oak-tree issuing out through small wounds made by certain insects; which insects not being found in this climate,no galls are here produced; though other kinds of e crescences are frequent on our oaks, occasioned, perhaps, by insects of another kind. It is not, as might be thought, on any particular species of the oak-tree that galls are formed; for Mr. Ray says, that in his travels abroad, he has seen them on the same kind of oak with that which is common here.

All the parts of the oak-tree seem to contain juices of nearly the same general virtue with galls; for the leaves, the acorns, and more particularly the bark and wood, strike with vitriol a black, or a deep colour, approaching to blackness. There are many other vegatable substances which have a like effect, in different degrees; as the leaves, small branches, and flowery clusters of the shumach tree, balustine flowers, pomegranate peel, alder bark, bistort root, and those, in general, which are austere, astringent, or corrugating to the taste; insomuch, that turning a solution of vitriol black is looked upon as a sure test of astringency in vegetables. The power by which they produce this blackness, and their astringency, or that by which they contract an animal fibre, and by which they contribute to the tanning of leather, seem to depend upon one and the same principle, and to be proportional to one another. Of the other properties of this astringent and colouring matter, little more is known, than that it is dissolved and extracted from the subject, both by water and spirit of wine; and it does not exhale in the evaporation of the liquors by heat.

Green vitriol, commonly called copperas, the other ingredient in the black mixture is a preparation of iron, made at Deptford, Blackwall, Newcastle, and some other parts of England, by boiling old iron with an acid liquor, which runs from certain pyrites, on being long exposed to the weather. By dissolving iron in the vitriolic acid, and crystallizing the solution, the same salt is obtained in a purer state.

When a decoction or infusion of the galls is dropped into a solution of the vitriol, largely diluted with water, the first drops produce blueish or purplish red clouds, which soon mingling with the liquor, tinge it uniformly of their own blueish or reddish colour. It seems to be on the quality of the water, that this difference in the colour depends. With distilled water, or the common spring waters, the mixture is always blue. If we previously dissolve in the water the most minute quantity of any alcaline salt, too small to be discoverable by any of the common means by which waters are examined; or if the water is in the least degree putrid, the colour of the mixture proves purple or reddish. Rain water, caught as it falls from the clouds, in an open field, in clean glass vessels, gives a blue; but such as is collected from the tops of houses grows purple with the vitriol and galls; from whence it may be presumed, that this last has contracted a putrid tendency, or received an alcaline impregnation, though so slight as not to be sensible on other ways of trial.

Both the blue and the purple liquors, on adding more of the astringent infusion, deepen to a black, more or less intense, according to the degree of dilution: if the mixture proves of a deep opaque blackness, it again becomes blueish or purplish when further diluted. If suffered to stand in this dilute state for two or three days, the colouring matter settles to the bottom in form of a fine black mud, which, by slightly shaking the vessel, is diffused again through the liquor, and tinges it of its former colour. When the mixture is of a full blackness, this separation does not happen, or in a far less degree; for though a part of the black matter precipitates in standing, yet so much remains dissolved that the liquor continues black. This suspension of the colouring substance in the black liquid may be attributed, in part, to the gummy matter of the astringent infusion, increasing the consistence of the watery fluid; for the separation is retarded in the diluted mixture by a small addition of gum arabic, though another principle appears also to concur for part of the effect.

If the mixture, either in its black or diluted state, be poured into a filtre, the liquor passes through coloured, only a part of the black matter remaining on the paper. The filtered liquor, to the eye perfectly homógene, on standing for some time becomes turbid, and full of fine black flakes; being freed from these, by a second filtration, it again contracts the same appearance, and this repeatedly, till all the colouring parts are separated, and the liquor has become colourless. It should seem, therefore, that there happens a gradual and slow concretion of the black corpuscles into particles large enough to subside by their own weight, or to be retained on a filtre; and this concretion is greatly influenced by dilution with water. Perhaps it is affected also by the action of the air; for, having once set some of the diluted matter to settle, in a close stopped glass, the separation of the black matter was remarkably more slow than in the other experiments, in which the vessel was open.

The colouring matter, thus separated from the liquor, being drained on a filter and dried, appeared of a deep black, which did not seem to have suffered any change on lying exposed to the air for upwards of four months. Made red-hot, it glowed and burnt, though without flaming, and became a rusty-brown powder, which was readily attracted by a magnetic bar, though, in its black state, the magnet had no action on it. The vitriolic acid, diluted with water, and digested on the black powder, dissolved greatest part of it, leaving only a very little quantity of whitish matter. Solution of pure fixed alcaline salt dissolved very little of it: the liquor received a reddish-brown colour, and the powder became blackish-brown. This residuum was attracted by the magnet, after being made red-hot, though not before: the alkaline tincture passed through a filter, and mixed with a solution of green vitriol, struck a deep brownish-black colour, nearly the same with that which results from mixing with the vitriolic solution, an alkaline tincture of galls.

From these experiments it seems to follow, that the colouring matter in the black mixture is iron, extricated from its acid solvent in a highly attenuated or divided state, and combined with a peculiar species of matter contained in astringent vegetables; which matter, after the watery fluid that the compound floats in has been separated, is, in part, extracted from the iron by alkaline liquors, and may thence be again transferred into fresh dissolved iron.

The blackness is generally attributed to the iron being barely revived from the vitriol in its metallic state; the black matter being supposed to be of the same nature with the impalpable black powder, into which fine iron filings are changed, by lying for many months under water. But this black matter differs from that of our mixtures in two very material properties. It is attracted, in its black state, by the magnet, and when moistened and exposed to the air, it changes speedily into rust. The resistance of ours to the magnet and to the air proceeds, doubtless, from the combination of the other matter with the iron; and there appears some analogy, in regard to the manner of production, between this black substance and Prussian blue; one being a precipitation and coalition of dissolved iron with one species of matter, and the other with another: the principal difference is, that the substance, combined with the Prussian blue, defends the metal from the action of acids, which that in the compound is unable to do.

I tried, likewise, solutions, and different soluble preparations of iron, made with the nitrous, muriatic, and vegetable acids; as also an alkaline solution of it, obtained in Stahl's method, by dropping into strong alkaline ley a solution of the metal made in the nitrous acid. All the preparations, in which the iron was dissolved by an acid, struck a black colour with astringents; but the alkaline solution gave only a reddish-brown. In this respect, also, the tinging substance in our mixtures agrees with that of Prussian blue.

It has been affirmed, that solutions of iron in the nitrous and muriatic acids, produce no blackness with astringents; and some trials, formerly made, led me into the same opinion. On re-examining this matter the fallacy appeared to lie here, that those acids do not very readily saturate themselves with the iron, and that any considerable quantity of redundant acid in the solution prevents the blackness. The case is not the same with the vitriolic acid; and probably if we had not, in the vitriol itself, a saturated combination of this acid with iron, ready prepared for other uses, the vitriolic solutions would as often have been found to refuse striking a black colour, as the nitrous and muriatic.

After the blackness has been produced, the addition of any of these acids, (and even of the vegetable in sufficient quantity,) destroys it, by re-dissolving the ferrugineous matter. Hence the use of acids and acidulated liquors for discharging stains made by the black mixtures, such as that of common ink. Alkalies also destroy the blackness, apparently on a different principle, by dissolving the astringent matter, and precipitating the iron nearly in the same ochery state as they do from the simple acid solutions of the metal. After the blackness has been discharged by an alkali, the addition of any acid, in such quantity as to saturate the alkali, restores it; and, after its discharge by an acid, it is, in like manner, restored again by an alkali.

Black from Silver.—Solution of silver in aqua-fortis, of itself colourless as water, dropped upon white bone, or other like animal substance, produces, at first, no stain. In some time, sooner or later, according as the subject is more or less exposed to the sun and air, the part moistened with the liquid becomes, first, of a reddish or purplish colour, which, by degrees, changes into a brown, and, at length, deepens to a black. Several kinds of stone and wood receive, from the same solution, purplish, reddish, blueish, brown, or black stains.

On what particular combination the colours here depend has not yet been explained, nor, indeed, so far as I can find, examined. The following observations, which we owe to a paper of Mr. Schulze, in the first volume of the "*Acta Naturæ Curiosorum,*" though they do not discover the cause of the effect, may contribute to its illustration.

White chalk, moistened with a solution of silver, and dried in the shade, or by a fire, receives no colour; dried in the sun, or exposed to the sun after it has been otherwise dried, it becomes on the surface of a purplish black. When the earth is thoroughly moistened with the solution, if so much water be added as will reduce it into a thin paste, the matter, in this state, also becomes coloured in the sun, though in the shade it acquires no tinge. The colour is produced in those parts only on which the sun shines: a thread applied on the ouside of the glass, between it and the sun, occasions a corresponding uncoloured vein on the included matter; and hence distinct characters may be exhibited on the mass, by intercepting a part of the sun's light by threads or cut paper.

I repeated these experiments, and observed that the colours produced were nearly the same with those which the solution of silver communicates to bone or ivory, except that they did not deepen to so true a black. The colour was entirely superficial; for when the matter, by now and then turning the glass in the sun, had been tinged all over to reddish or brownish black, it appeared white again, when shaken and mixed together. By continuing the exposure for many weeks, and frequently shaking the mixture, that fresh surfaces of it might be successively acted upon by the sun, it became, at length, coloured, though weakly, throughout. The sun's rays in December produced the same change as in June, and, so far as can he recollected, as speedily. The light of candles, and a gentle warmth from a common fire, did not seem to affect the colour. In a considerable heat, greater than that of the sun in summer, the matter became brown, but without acquiring the black colour which the sun communicates.

I tried also several other earthy bodies, and found that those which dissolve in acids, the ashes of vegetables, and of bones and horns, suffered the same changes as chalk, and the other mineral calcareous earths. But powdered flint, however moistened and drenched in the solution, received no colour, in half a year's exposure to the sun. White clay, plaster of Paris, and powdered talc, remained also uncoloured; and even chalk itself, previously saturated with the vitriolic acid, so as not to be acted upon by the acid in which the silver was dissolved, suffered no change.

It should seem, from these experiments, that, in order to the production of a black stain from solution of silver, it is necessary that the subject moistened with it be not only exposed to the solar light, but that it contains some matter which the nitrous acid may dissolve, preferably to the silver which it already holds dissolved. This is plainly the case in bones, horn, hair, marble, and several other bodies, which are stained by the silver solution; though there are also some stones which are stained by it, as agate, in which a substance, soluble by the acid, has not yet discovered itself.

It may be observed, that the production of a dark colour from the action of the sun is not peculiar to solution of silver, or to a combination of this solution with soluble earths. When bismuth is dissolved in the nitrous acid, and afterwards precipitated by dilution with water, the precipitated powder, exceedingly white, soon becomes dark coloured in the sun, so as to require great care, in drying and keeping it, to preserve the whiteness, for which this preparation is valued. *Mercurius dulcis*, a combination of quicksilver with the muriatic acid suffers a like change. The effect, however, is less considerable here than in the silver liquor; for, though both preparations become dark, I have not observed blackness produced in either.

Black from Lead and Sulphur.—Lead, which of itself makes a blackish mark on paper, yields colours, more or less approaching to blackness, in some of its solutions and combinations with other bodies. Solutions of lead, made in acids, dropped upon paper, or other white subjects, communicate no stain; but on being exposed to sulphureous vapours, or washed over with alcaline solutions of sulphur (hydro-sulphurate), the parts moistened with the solution of lead immediately become yellow, and soon after of a deep brown or black, according as the liquors were more or less saturated with the matters dissolved in them.

The production of this colour has not been applied to any important use, being regarded chiefly as a matter of curiosity, as affording the foundation of one of the writings called invisible or sympathetic. For this purpose, vinegar is strongly impregnated with lead, by boiling with litharge, ceruse, or other calces of the metal; or, what amounts to the same thing, the common preparation called sugar of lead, (acetate of lead), is dissolved in water: solutions of lead in aqua fortis answer the same end, except that, when written with, they are apt to corrode the paper. The sulphureous liquor is commonly prepared by boiling some orpiment, which is a natural mixture of sulphur and arsenic in water, with quicklime, until the water is strongly impregnated with the orpiment: in the room of this preparation may be used a saturated solution of common brimstone, made by boiling the brimstone either with quick-lime or in strong alcaline ley. Characters written with the lead solution, which, when gently dried in the air, are not to be distinguished from the rest of the paper, become of a legible deep colour, on passing over them a pencil dipped in the sulphureous solution. Those who amuse themselves with this experiment, have black characters in the neighbourhood of the invisible ones; which black ones are drawn with burnt cork, or other charcoal blacks, mixed only with water: by the wet pencil these are washed off, at the same time the others are made to appear.

If any acid be added to the sulphureous solution, a very offensive smell arises; and a solution of sulphur, made in strong volatile spirits (ammonia), prepared with quick-lime, exhales a like smell. The penetrating diffusive vapour, particularly that of the last of these preparations, gives colour to the invisible writing with the lead solution at a considerable distance; though the writing be placed in the middle of a quire of paper, or of a pretty thick book, the vapour will soon reach it, and stain it brown or black. The colour is discharged by acids, and restored again by the sulphureous vapour or solution.

Calces of lead, melted with sulphur, form a black or blackish mass, which proves an useful matter for taking casts from medals, being considerably more tough than sulphur alone. For this purpose, equal parts of minium and flowers of sulphur are put in an iron ladle over the fire, till they soften into the consistence of pap, and are then kindled with a piece of lighted paper, and stirred for some time: the vessel being afterwards covered close and continued on the fire, the mixture becomes fluid in a few minutes, and is then poured upon the medal previously oiled and wiped clean. This process, communicated to me by a friend, I have often tried with satisfaction. The casts are very neat: the colour, sometimes a pretty deep black, and sometimes a black-grey, according to different circumstances in the fusion; they are very durable, and when soiled, may be washed clean again with spirit of wine.

There are other metals also which produce a black colour with sulphureous bodies. When a solution of silver in aqua-fortis is added to a solution of sulphur made in alcaline ley, the silver and sulphur unite and precipitate together in the form of a black powder. Quicksilver and sulphur, by being merely rubbed together in a mortar, become black; and hence this mixture, commonly made for medicinal use, is called the mineral ethiops. But as these kinds of compositions afford nothing of importance for the art of colouring black, it would be needless in this place to consider them more particularly.

Black from the combination of other colours.—In the three foregoing articles we have seen blackness generated from the action of certain bodies on one another, and in the preceding section, from alterations produced in the bodies themselves, or their component parts. There is another general principle, on which some of the most common colours are obtained, the combination of two or more differently coloured bodies together, whence results a new colour, compounded of those of the ingredients: thus green is formed from a mixture of black and yellow, and purple from blue and red. These compound colours are found to succeed, by grinding together coloured earthy powders;

by uniting coloured flames, or the sun's beams which have passed coloured through glasses; by mixing dyed wool, threads, &c., where there can be no suspicion of any intrinsic change made in the subjects, or of any action of the ingredients on one another.

M. le Blon, in his "Harmony of Colours," forms black on the same foundation, by mixing together the three colours called primitive, blue, red and yellow; and M. Castel, in his "*Optique des Couleurs*," published in 1740, says, that this compound black has an advantage in painting, above the simple ones, of answering better for the darkening of other colours. Thus if blue, by the addition of black, is to be darkened into a blue black, the simple blacks, according to him, if used in sufficient quantity to produce the requisite deepness, conceal the blue, while the compound blacks leave it distinguishable.

Le Blon does not mention the proportions of the three primitive colours necessary for producing black. Castel directs fifteen parts of blue, five of red, and three of yellow; but takes notice that these proportions are rather speculatively than practically just, and that the eye only can be the true judge; our colours being all very imperfect, and our pigments or other bodies of one denomination of colours, being very unequal in its degree or intensity. He observes that the colours should each be the deepest and darkest in its kind; and that, instead of taking one pigment for each colour, it is better to take as many as can be got; for the greater contrast there is of heterogeneous and discordant drugs, the more true and beautiful, he says, will the black be, and the more capable of uniting with all the other colours, without suppressing them, and even without making them tawney.

The trials I have made of mixing different blue, red, and yellow powders, have not succeeded so far as to afford a perfect black; but I have often obtained from them very dark colours, such as may be called brown-blacks and grey-blacks, such as we commonly see in the dark parts of paintings, and such as the charcoal and soot blacks appear when diluted a little. The ingredients being each of a dark deep colour, is a very necessary condition; for bright blues, bright reds, and bright yellows, mixed in such proportions that neither colour prevailed, produced only a grey. In effect, all compositions of this kind, physically considered, can be no other than greys, or of some of the intermediate tints between whiteness and blackness; and these greys will be so much the lighter or darker, as the component colours of themselves are bright or dark. Some further experiments of producing a black by composition, for the purposes of dyeing and staining, will be mentioned in the sequel of this essay.

(*To be continued*)

XXVIII.—*On Improvements on the Balance-Lock, or Inclined Plane, intended as a substitute for Locks on Canals; especially on such Canals as have a great Lift, but a scarcity of Water. By Mr.* MINUS WARD, *Civil Engineer**.

IN order the better to illustrate the utility of the invention, we will first describe the whole machine, and afterwards point out those particular parts which are new and peculiar. The two sections then of the canal, which are upon different levels, are to be brought, the one to the foot, and the other to the top of that declivity of the ground, which may present itself as most favourable for the site of the works. The lower section of the canal terminates at the foot of the declivity in form of a basin, of a sufficient area and depth for the purpose intended. The upper section of the canal branches off, a small distance above the works, into two branches, which branches terminate in open mouths, constructed with two side walls, and a flooring of hewn stone each; they terminate abruptly, at right angles to their length, and are so situated as to stand with their mouths pointing directly towards each other; the upper side walls of each, or those next the hill, being in the same straight line; and the lower walls of each are in a like situation with respect to each other. These mouths are but a few inches wider than the width of the boats intended to be navigated upon the canal, and of a depth no greater than is sufficient to float a boat when loaded. The distance between these two mouths exceeds, by a few inches, the aggregate length of the two moveable receptacles in which the boats are contained during their ascent and descent; which receptacles we will call the *cradles*, and of which a more particular description will be given farther on. But to return to the mouths belonging to the upper canal: each of these mouths is furnished with a *sliding mouth-piece*, constructed of sheet iron, one-fourth of an inch in thickness, rivetted together in the manner of steam-engine boilers, with their bottoms horizontal, and sides vertical, with both their ends open, excepting when those towards each other are occasionally closed with gates; these mouth-peices we will hereafter call the *connectors*: they want two inches on each side of being as wide as the stone mouths, in which they work; they need not exceed three feet in length each, in the direction parellel to the walls, and to their own motion; they are supported at the ends towards each other by a ledge of wood, extending across, and being made fast to the bottom of the stone mouth: two other pieces extend up, one on each side, to the tops of the walls, so as to fill the space between the outsides of the connector, and the inside of the stone-mouths. In like manner the other ends are supported by similar pieces of wood, except that each is furnished with two of those ledges, placed three inches apart; the three-inch groove thus formed between the ledges is filled with oiled hemp, so that the sliding piece can move backwards and forwards upon the hemp, in a direction parellel with the walls, and yet no water can pass between the sliding mouth-pieces and the stationary stone mouths. Each of these connectors is furnished with a pair of gates, also of sheet iron, hung upon the ends of the connectors towards each other, by hinges on each side, and meeting together in a straight line, when closed in the centre of the breadth of the sliding mouth-piece, each pair of gates opening into the cavity between the walls; their bottoms resting against a flanch of three inches in breadth, formed by turning in the edge of the connector; they rest also at their sides. The tops of these gates, in order to save room, are furnished with a bar or brace of iron, extending across the tops of the gates, nearly to the hinge side of each; this brace is supported, however, by only one horizontal screw bolt, in the wing of one of the gates, so that it can be turned up in a vertical position, at the time of opening and shutting the gates. These connectors have each a rack, made fast to the under sides of their bottoms, with a shaft extending across, under each, and a pinion made fast to each shaft, working into the racks. Those shafts project out on the upper side, beyond the outsides of the walls, with a rachet wheel, six feet diameter, on the outer end of each shaft, and a click to hold both ways; so that, with regard to this ratchet wheel, its shaft, pinion, and the rack in which it works, as also the motion or effect produced, is precisely the same as it is in the well known contrivance for the carriage of a saw-mill; except that the clicks are made to hold in either direction, as the case may require. The ends of these connectors, towards each other, extend a few inches beyond the terminations or ends of the stone mouths. We have already stated, that each connector is furnished with a flanch for the gates to shut against, but those flanches serve another, and a very remarkable purpose, and upon which the facility and dispatch of passing a boat, in a great measure, depend. The faces of these flanches, towards each other, are armed with about a dozen thicknesses of canvass.

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* From the *Franklin Journal.* We have already published an account of Mr. Ward's alternating steam-engine, and his theory of the application of cranks to steam-engines, in the second vol. of the *Technical Repository.*

The two cradles are constructed also of thick sheet iron, each of a capacity sufficient to contain the boat; each of them is furnished with a separate chamber under its bottom of a capacity to hold a quantity of water, so that when one of the cradles has this lower chamber filled with water, and the other cradle, at the same time, having its inferior chamber empty, a preponderating force is obtained, sufficient to give the requisite velocity to the cradle. These cradles are mounted upon cast-iron wheels, and move up and down, side foremost, upon cast-iron railways, placed in an inclined position, to suit the inclination of the ground, not being confined to any particular inclination or height. The cradles are so situated as to pass each other, leaving a few inches between their ends at the time of passing. Their ends towards each other are closed, the other ends are each furnished with flanches and a pair of gates exactly similar to those already described. The gates open into the cavity of the cradle. The bottoms of the lower chambers are constructed so as to incline to the horizon in an angle nearly equal to the angle of the rails, and in the same direction, forming an acute angle with the lower sides of the cradles; this will cause the cradles to enter the water in the manner of a wedge, causing little or no collision. A strong frame-work of timber, covered with a shed, is placed upon the brow of the declivity at the upper end of the railways, in which are supported six drums of cast-iron, furnished with fly wheels of the same metal; from three of these drums a like number of chains extend to the ends and to the middle of one of the cradles, and from the other three drums chains extend in like manner to the other cradle, connecting chains extend also from one set of drums to the other, so that one cradle cannot descend without causing the other to ascend, or, perhaps, instead of placing the drums vertical, and using connecting chains. A better modification would be to place all the drums on one horizontal shaft, extending the whole length across the top of the rails; this shaft should be cast hollow, of a diameter and thickness of metal sufficient to insure it from twisting off, with a gudgeon at each end, and supported in a sufficient number of places along the shaft, by resting upon the circumferences of other wheels, generally termed friction wheels; the chains from one cradle to one set of drums wind on to the drums by their under sides, and those from the other cradle wind on by the upper sides of the other set of drums, with but one fly-wheel in the middle of the shaft. These chains are of such a length, that when one cradle is in a line with its corresponding connector, the other is immersed in the water of the basin below, so that its upper edge shall be level with the surface of the water. The inclined railways extend down into the basin deeper than the cradles are intended to descend, and there are six of them, three for each cradle. The fly-wheels are furnished with brakes; these consist of a strap of iron extending round the wheel for about three-fourths of its circumference, and furnished at one end with a lever to give the necessary purchase; the other end is made fast to a stationary stud. When the lever is pressed upon with the hand, the strap binds hard upon the extreme surface of the fly-wheel, thereby causing great friction; at other times it does not touch the wheel. Each cradle is furnished with a strong pall in the middle of its length, to stop in a line with the connector, while the boats are floated in and out; the brakes are also drawn at the same time hard down upon the fly-wheels, and hooked fast, and assist very much in holding the cradles still. The operation is as follows:—Suppose one of the cradles, to be held by its pall, assisted by the brakes, the keeper goes to the ratchet wheel of the connector corresponding to this cradle, throws out the click which holds the connector back, and applies his foot upon the pins placed in the side of the ratchet wheel for that purpose, and turns it round; this forces out the connector, and brings its armed flanch directly into contact with the corresponding flanch upon the cradle, and presses them together with sufficient force to make the joining water tight when they are held in this position by the click; then, by drawing a small wicket-gate in one of the gates belonging to the connector, the water of the upper section rushes in, and instantly fills the small space between the two pair of gates, when these last may be opened with ease, for the pressure is now equal on every side. A boat intended to descend may now pass directly into this cradle, for it has in this position become a part and extension of the upper section of the canal; but as the other cradle is at this period immersed up to its top in the basin below, so a boat wished to ascend may open the gates (for the pressure is equal also on each side of these gates) and pass into this cradle, and close the gates behind the boat; but before it can ascend the boatman must draw a gate, which will suffer the water to run out of the inferior chamber of his cradle. This it cannot do, however, until the cradle is suffered to rise, because the chamber is entirely under water; but by this time the keeper has closed the two pair of gates above, thrown out the click which held the connector pressed against the upper cradle, drawn back the connector far enough to clear it from the cradle, say two inches, the small quantity of water which was contained between the two pair of gates drops down, and runs along a gutter into the basin; then by first letting go the pall, and next unhooking the lever of the brakes, this cradle (having had its lower chamber filled with water previous to the closing of the gates, by drawing a horizontal valve in the bottom of the upper chamber of the cradle) will preponderate and raise the other, so as to bring the surface of the water in its inferior chamber above the surface of the water in the basin, when the water contained in the chamber commences, and continues to run out as the cradle rises, until it is all discharged; the other cradle is suffered to come down with an accelerated motion, the velocity of which descent must be so regulated by the quantity of water which has been suffered to run into the inferior chamber, as to cause the fly-wheels to perform a peculiar office assigned them, which is this—when the descending cradle has reached the surface of the water in the basin, and its submersion commenced, the buoyancy of the water contained in the basin gradually takes off, and finally destroys its preponderating force, and an equilibrium will be attained at a point somewhere between the commencement and the termination of the submersion of the cradle; that is, if the cradle were suffered to come to an equilibrium, the upper cradle would be found, by reason of the buoyancy of the water in the basin acting upon the other cradle, to be something below its corresponding connector.

The requisite accelerated motion spoken of, and the effect to be produced by the *vis inertiæ* of the fly-wheels is, to carry the ascending cradle somewhat higher than the connector, where it is caught by the brakes, and suffered to return gently upon the pall; but it would not return upon the pall with an injurious velocity, if no friction was applied; because the lower cradle having become surrounded with water, can move side foremost through it, but with a slow motion, beginning, as it does, from a state of rest, and not passing over more than from twelve to eighteen inches. The keeper then, by going through the same operation with this side of the machine, forms, by means of the ratchet-wheel and connector, the connection between this cradle and this branch of the canal; the wicket, or small gate, is drawn, the two pairs of gates are opened, and the boat which has thus ascended is at liberty to depart on its way; and another ready to descend may take its place in this cradle, and close the gates behind it, when the communication may be cut off by drawing back the connector, as it was on the other side; in the mean time, the boat which has descended, having now the top of its cradle upon a level with the surface of the water in the basin, is at liberty to open the gates of this cradle, and to depart; another boat ascending may now take its place, and close the gates behind it. One half of the apparatus being an exact counterpart of the other, the ascent of this cradle and the descent of the other is but a repetition of the process already described; this part of the apparatus performing now what was before performed by the other, and so on alternately. But it is evident by this arrangement, that we can not only thus ascend with one boat, and at the the same time descend with another, but that a boat may ascend without the necessity of waiting for another to arrive to descend at the same time, and *vice versa;* because the superior chambers being always full of water, the entrance of the boat, by displacing its own weight of water, causes no addition to the weight of the cradles.

The points of difference between this balance-lock and others which have been proposed, some of which are in operation, appear to be, first, and principally, in the facility and dispatch, which, by means of the sliding mouth-pieces, we are enabled to form, and to cut off at pleasure, the communication between the cradles and the upper section of the canal; secondly, in the use of the *vis inertiæ* of the fly-wheels, in carrying the cradles beyond the point of equilibrium, thereby avoiding the necessity of a set of mouths at the lower ends of the inclined-rails, like to those above, which would otherwise be necessary; and, thirdly, in the manner of hanging the gates, and of bracing them across their tops by the revolving bar.

A farther description of Ward's Balance Lock.

SIR, *Baltimore, Jan.* 11, 1827.

The accompanying description of "The Balance Lock," &c., was written in the year 1824, and published in "The Baltimore American," of the 15th Dec. 1824.

On mature reflexion, I deem it advisable to give a general outline of the principal features of the machine; and I also add a farther description of that most essential part of the invention "the connectors."

First, the cradles of this machine move up and down upon the inclined rail-way, *side foremost,* as proposed by the late Mr. Robert Fulton. [Vide "Repertory of Arts," vol. vii. p. 222.] This enables us to lay the rails with an elevation of about 80 degrees to the horizon, which saves a considerable proportion of the expense, by shortening their length, and enables us to give the cradles a much greater velocity, they being allowed to run on until they stop spontaneously; no solid body being interposed in the line of their motion, which is the case if we attempt to move the cradles end foremost.

Secondly. The preponderating power is obtained, by filling wth water, and emptying, as occasion may require, an extra chamber, attached to the cradles, as proposed by Leach, an English engineer. [Vide Rees's Encyclopœdia.].

Thirdly. The ascending cradle is carried above the point of equilibrium, and also above the corresponding mouth of the canal, by means of the *vis inertiæ* of a large fly-wheel, attached to the horizontal shaft, upon which the chains from the cradles are coiled, without the necessity of introducing cog-wheels, which would be expensive, making the machine complicated, and even dangerous. The *vis inertiæ* of the fly-wheel causes the machine to overrun the point of equilibrium; and as it returns again, upon the principle of common vibrating bodies, being still urged towards the point of equilibrium, it is arrested at the proper time and place by the pall. This I claim as my invention, and believe it to be better entitled to the character of "boldness,"* than are other plans which have lately been published.

Fourthly. The method of *forming and cutting off* the communication between the cradles, and the corresponding mouth of the canal above, by means of *sliding connectors*, moving, water-tight, through a packing of oiled hemp, I also claim as my invention. This part of the machine completely removes the difficulty heretofore existing, in forming a water-tight connection between the cradle and the upper section of the canal; a difficulty foreseen by the able committee of the *Franklin Institute*, who reported on professor Renwick's inclined plane.

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* See "Report on Professor Renwick's Inclined Plane," Vol. xi. of the *Technical Repository*, page 172.

In the description of my inclined plane, published in "*The Baltimore American*," I proposed to use two or more chains; this idea, therefore, was not new when Professor Renwick published his views upon the subject.

Fifthly. The method of hanging the gates, to form a straight line across the cradle, and the method of supporting them by means of the revolving bar at the top, I also claim as my invention.

After farther consideration of my *connectors*, I propose to have three racks to each *connector*, with a pinion, shafts, rachet-wheel, and click, to each rack, entirely separate and distinct from each other: viz. one under the centre of the connector, as proposed in my description, dated 1824; and one on each side, at the top edge of the connector. The rack-bar of the rack below must be fixed to the bottom of the connector by a single bolt, and allowed to turn freely on the said bolt. The connector should also be made short, in the direction of its motion, say only 12 inches. By this arrangement, if one end of the cradle should gain upon the other end in winding up, so as to make a difference of an inch or two at the parts of contact between it and the cradle, when you come to force the connector out against the cradle, if one end of the connector touch the cradle first, it is free to turn upon the bolt in the centre, and allow the other side to come up also. The complete contact of the two surfaces is farther facilitated by the two racks above.

A model which I had made in 1824 was seen in operation in this city by Robert Smith, Esq. formerly Secretary of State, U. S.; J. S. Sullivan, civil engineer; Captain Pouissin, topographical engineer, U. S.; and Lieut. Sherbourn, hydrographer, U. S. N.

By inserting the above remarks, together with the accompanying description, in your useful journal, you will much oblige, sir, your obedient servant,

To Dr. THOMAS P. JONES. MINUS WARD.

XXIX.—Editor *on a Nautical Table Apparatus. Made by Messrs. King, Heath, and Co. London.*

WITH A PLATE.

Many of our readers have, no doubt, experienced the unpleasant effects of a sudden *lurch,* as it is termed, or the violent pitching of a vessel at sea, in hard gales, in quickly scattering the table service, or at least such parts of it as happen to be loose, in all directions, to the great loss by fracture of the glass and earthernware, and to the injury of the other parts composing it. An effectual remedy for this evil cannot, therefore, but be well received by the public in general, and especially by all those who are compelled to pass great part of their lives on that stormy element.

An officer engaged in the marine department of his majesty's service, having long experienced the evils resulting from such accidents, set his thoughts to work, to endeavour to find a better remedy for these disasters, than the clumsy and inefficient ones of sand-bags arranged along the edges of the tables, skippers, &c., hitherto employed; and has been fortunate enough, in conjunction with the practical experience of Messrs. King and Heath, as extensive manufacturers of tin-ware, &c., to construct a very simple, useful, and portable apparatus.

In plate IV. we have represented one construction of this nautical table apparatus, although it is evident it will admit of many modifications, suited to the particular objects it is designed for. In this case, it represents an apparatus, contrived for the especial use of the dinner table; the plate, knife and fork, spoon and silver fork, as well as the drinking-glass, goblet, and wine-glass, being securely held in their proper places by the frame and its appendages; and which frame is itself securely bound fast, by a screw-clamp under the table, and as shown in the left hand figure in the plate. The other figure represents the same table apparatus, *in its very portable form,* most of the appendages being turned down, upon their joints or hinges, into the inside of the cylindrical ring or frame, and the screw-clamp turned upwards into its situation within the ring.

XXX.—*On the realization of the Rail-way for the conveyance of the Anthracite or Stone-coal from the Wilkes-barre Mines to the Lehigh River, a distance of nine miles.*

In our tenth volume of the *Technical Repository*, p. 236, in a letter to the Editor from Erskine Hazard, Esq., he stated that " a railway was constructing, which will have sufficient fall for the full waggons to run down of themselves, and carry with them, on stages, the horses which serve to draw the empty waggons up again to the mine!

We have just seen a letter from that gentleman to Mr. J. Perkins, dated Philadelphia, June 13, 1827, in which he says, " Our rail-road is completed, and succeeds admirably. The waggons run from the mine to the river by gravity merely, and carry the horse on a platform, nine miles, whilst eating his food. The motion of the waggon is regulated by friction, as in England. One of the waggons was carelessly let go of itself, and is supposed not to have occupied more than ten minutes in the trip. The usual time of the descent is from 35 to 40 minutes. The horse takes the empty waggon back. The horses have frequently travelled four miles on the rail-way in nine minutes; and I have myself gone that distance in 12½ minutes, which I thought quite fast enough for pleasure!"

XXXI.—*On an American improvement on the Paddle-wheels of Steam-boats.*

In the above-mentioned letter, Mr. Hazard informed Mr. Perkins, that the paddle-wheels of the steam-boats at Philadelphia now have their buckets divided, so as to have one-third of the length of the bucket always at right-angles, or nearly so, with the water, and yet not to have them set too closely together, and each division of the bucket is on a separate arm."

This judicious disposition of the buckets, or dividing each bucket into three parts lengthways, and arranging them in a spiral manner around the axis, so as continually to break-joint, as it were, must necessarily have the effect of greatly contributing to the smoothness of the vessel's motion through the water, and also of increasing the comfort of the passengers, by lessening the shocks occasioned by a long bucket suddenly entering the water, as is comcommonly the case.

We recollect an instance of a similar contrivance being applied to the immense undershot water-wheels at Messrs. Strutt's cotton-mills, at Belper, near Derby, and which are worked by the full power of the stream of the river Derwent; one of these wheels is forty feet long; and, but for this happy contrivance of breaking-joint in their float-boards, the mill would have been constantly shaken at the entrance of every float-board into the water, as indeed was the case before this alteration was adopted.

XXXIII.—*On the new High-pressure Steam-engine, constructed by* Jacob Perkins, *Esq. Civil Engineer, London.*

The Editor was highly gratified on Wednesday, the 10th ult., by witnessing the performance of this engine at the St. Catherine's Docks, where, as Mr. Hornblower (a nephew of the celebrated Mr. Hornblower), the intelligent engineer and superintendent of it, informed him, it had been incessantly at work, night and day, from 12 o'clock on the Friday night preceding, and had alone kept the excavations free from water, although the river had once made an entrance to a very considerable extent.

At the time the Editor saw it, it was working two pumps;

but, owing to its having got the water so completely under, it was then drawing air mixed with the water.

Mr. Hornblower stated, that it was then working at a pressure of about 270lbs. upon the square inch, it not being one-third of its full power; and that it only consumed at the rate of one bushel of coals per hour; but that it ordinarily did the work of a 12-horse engine.

Its motion was exceedingly rapid, and indeed it was necessary to abate its velocity by the introduction of a pinion, fixed upon its main-shaft, working into a larger toothed wheel upon the crank-shaft which actuated the pumps; and, owing to its working with so great a velocity, one of the great advantages of working high-pressure steam, the engine itself is of a very light construction, and not requiring such massive shafts, &c., to be employed, as in the ordinary cases of the low-pressure steam-engines.

Mr. Hornblower stated, that another engine employed to drain the excavations consumed two and a half bushels of coals per hour.

We understand, that the chief objects which Mr. Perkins's improvements upon the steam-engine embraces are the following:—

Firstly. The keeping the water under a powerful pressure, and thus preventing it from expanding into steam, until required for use; and also in a peculiar method of making pure steam.

Secondly. In so constructing an engine, as to get rid of all the re-action and resistance of the steam, on the eduction side of the piston.

Thirdly. In constructing a flexible metallic piston in such a manner as to be steam-tight, although the cylinder, from wear, or any other cause, should become of an unequal calibre; and likewise so as not to require the use of any oil or other lubrifaction.

Fourthly. In making a vacuum in the eduction side of the piston, without employing an air pump, or the usual quantity of condensing water.

Fifthly. In so arranging the tubes of the generator, in which the water is heated, that the temperature of the metal should not be so much above that of the water as to cause an unequal contraction.

Sixthly. In the manner of making the steam-tight joints.

And, lastly, in so modifying the furnace, as to retain a large portion of the caloric, which would otherwise escape up the chimney.

The particular means by which these highly desirable objects are accomplished, will be described in the specification of a patent which Mr. Perkins has lately obtained for his improvements.

LIST OF PATENTS FOR NEW INVENTIONS,

Which have passed the Great Seal since June 21, 1827.

To Henry Roper, of Baker-street, in the parish of St. Mary-le-bone, in the county of Middlesex, Esq., a Rear-Admiral in our Royal Navy; for a new and improved system of signals; first, for communicating by day, by the means of flags and pendants, between ships at sea, or other objects far distant from each other; in which system the colours of the flags and pendants, which have heretofore served to distinguish the signals one from another, and which, by distance and other causes, are extremely subject to be mistaken, may be dispensed with altogether; and, secondly, for communicating by night, between ships at sea, and other objects far distant from each other, by the means of lights, and which system of signals is more conspicuous, expeditious, and certain, than any which has hitherto been employed for the like purpose. Dated June 21, 1827.—To be spicified in two months.

To James Marshall, of Chatham, in the county of Kent, Lieutenant in the Royal Navy; for improvements in mounting guns or cannon, for sea or other service. Dated June 26, 1827. —In six months.

To John Felton, of Hinckley, in the county of Leicester, machine-maker, for a machine for an expeditious and correct mode of giving a fine edge to knives, razors, scissors, and other cutting instruments. Dated June 28, 1827.—In two months, To Thomas Fuller, of Bath, in the county of Somerset, coach-maker, for certain improvements on wheel-carriages. Dated June 28, 1827.—In two months.

To Walker Hancock, of Stratford, in the county of Essex, Engineer; for an improvement or improvements upon steam-engines. Dated July 4, 1827.—In six months.

To William Wilson, of Martin's-lane, Cannon-street, in the city of London, hat-manufacturer; for a means or principle of extracting spirits, and other solvents, used in dissolving or rendering soluble gums of various kinds, and other articles employed for stiffening hats, hat bodies, bonnets, caps, and various other articles of merchandize; and converting such spirit (after rectification) into use. Dated July 4, 1827.—In two months.

To René Florentin Jenar, of Bunhill-row, in the parish of St. Luke, Gentleman; for certain improvements in lamps. Dated July 4, 1827.—In six months.

To George Poulton, of Stafford-street, Old Bond-street, in the county of Middlesex, tailor; for an instrument, machine, or apparatus for writing, which he denominates "a self-supplying pen." Dated July 4, 1827.—In six months.

To Thomas Sowerby, of Change-alley Cornhill, in the city of London, merchant; for certain improvements in the construction of ships' windlasses. Dated July 4, 1827.—In two months.

To René Florentin Jenar, of Bunhill-row, in the parish of St. Luke, gentleman; for a method of filling up with metal, or other suitable materials, the holes and interstices in wire-gauze, or other similar substances, which he denominates "Metallic Linen." Dated July 4, 1827.—In six months.

To John Snelson Shenton, of Husband Bosworth, in the county of Leicester, plumber and glazier; for certain improvements in the mechanism of water-closets. Dated July 12, 1827. —In six months.

To Edward Barnard Deeble, of St. James's-street, Westminster, in the county of Middlesex, Civil Engineer; for a new construction or constructions, and combination or combinations, of metallic blocks, for the purposes of forming caissons, jetties, piers, quays, embankments, light-houses, foundations, walls, or such other erections to which the said metallic blocks may be applicable. Dated July 12, 1827.—In six months.

To Robert Vazie, of York-square, in the parish of St. Pancras, in the county of Middlesex, Civil Engineer; for improvements in certain processes, utensils, apparatus, machinery, and operations, applicable to the preparing, extracting, and preserving various articles of food; the component parts of which utensils, apparatus, and machinery, are of different dimensions, proportionate to the different uses in which they are employed, and may be separately applied in preparing, extracting, and preserving food, and in other useful purposes. Dated July 12, 1827. —In six months.

To William Church, of Birmingham, in the county of Warwick, Esq.; for certain improvements in apparatus for spinning fibrous substances. Dated July 13, 1827.—In six months.

To George Anthony Sharp, of Putney, in the county of Surrey, Esq.; for an improved table urn. Dated July 18, 1827.—In six months.

To Robert Moore, of Underwood, Sterlingshire, in that part of our United Kingdom called Scotland, distiller; who, in consequence of communications made to him by certain foreigners residing abroad, and discoveries made by himself, is in possession of certain improvements in the process of preparing, and cooling worts, or wash, from vegetable substances, for the production of spirits. Dated July 18, 1827.—In six months.

To Robert Moore, of Underwood, Sterlingshire, in that part of our United Kingdom called Scotland, distiller; who, in consequence of communications made to him by certain foreigners residing abroad, and discoveries made by himself, is in possession of certain processes for rendering distillery refuse productive of spirits. Dated July 18, 1827.—In six months.

GILL'S
TECHNOLOGICAL REPOSITORY.

XXXIV.—*On Splitting, Cutting, and Polishing Diamonds, and on forming, mounting, and using Engravers', Glaziers', and Writing Diamonds, Diamond Dust, &c. By Mr.* EDMUND TURRELL, *Engraver.*

WITH A PLATE

(*Continued from p.* 73.)

On Watch Jewelling.—There is no department of the arts to which the diamond has been more succesfully applied than to the delicate, curious, and useful conversion of rubies, and other precious stones, for the purposes of *watch jewelling.* The most prevailing opinion with the public in general is, that the minute holes, in which the steel pivots of watches, clocks, and the best chronometers move, are made of diamonds, but that is not the case; the fact is, that they are most generally made of small pieces of ruby, which are first cut or slit into thin plates, and in this state are pierced by very fine diamond drills; they are then fixed upon fine steel arbors, and placed in a lathe, in order to have their external edges made perfectly cylindrical; which being done, they are fixed in a suitable small chuck, and the holes are finished, by being polished with diamond powder.

As the apparatus or tools used by the watch and clock jewellers are not generally known, I trust the ingenuity displayed in their construction, and also in the methods of using them, will prove interesting to your scientific readers, and the public in general, who have not had an opportunity of seeing this curious and useful art practised.

In plate V. fig. 1 shows a front and end view of part of a brass-mounted lathe, containing a steel collar A, and mandrel B. The bottom plate of the frame is dovetailed at C, so as to enter a dovetailed groove made in a corresponding plate fixed to the workboard, and where it can be made fast by a screw; and when not in use it may be removed from its place, and then the board is clear for other tools necessary in this art.

The end of the mandrel is tapped, or cut into a fine screw, externally and also internally, in order to receive various sized chucks, such as are shown in figures 2, 3, 4, 5, 6, 7, and 8. These chucks are shown of their proper sizes, the frame and mandrel however being drawn to a scale of only one half their real dimensions.

Fig. 2 is a side view of one of the chucks, it having a brass conical pin *a*, or axis, fixed to it, which has a thin circular plate of metal, *b*, fixed to its end by a screw or rivet. Plates of this kind are made either of copper, steel, brass, or soft iron; and they are used to slit the rough rubies, or other suitable stones, into thin lamina or plates, which is done by applying powdered *bort* to the edge of the thin plate, when it is fixed in the lathe and set in rapid motion. The rubies or other stones to be slit are fixed to any convenient handle by shell-lac, which is the cement most commonly used; and being held in contact with the edge of the slitter, a thin plate or slice will soon be separated. Several of these thin slips or plates are then cemented to a flat plate of metal, and being pressed in contact with the surface of a brass mill or flat lap, shown at fig. 11, well charged with *bort*, by it being imbedded, or either hammered or rolled into its surface, the whole of the plates will be reduced to one uniform and even plane surface, but in this case they will be what is technically called *grey*. A copper mill, of the same size, is then fixed in the lathe, and charged with the finest diamond powder, which produces the requisite polish, and consequently finishes one side of each plate or slip. They are then taken off the metal plate, and being reversed, they are then again cemented upon the metal plate, and the other rough sides treated in the same manner, by which means they will be made nicely parallel, and both sides be beautifully polished.

The next department is that of drilling; this is effected by selecting a very delicate splinter of diamond from a parcel of *bort* slightly powdered, which is then cemented to the end of a piece of fine steel wire, the sharp, angular point of the diamond protruding. This drill is fixed into a suitable chuck; and when it is screwed in the lathe, and set in motion, the slip of ruby, being previously cemented to a suitable plate of metal, is held or slightly pressed against the point of the drill, until a very fine conical hole is made nearly through it. The slip of ruby is then turned, and cemented to its plate again; and the drill completes the piercing, by meeting the part or cavity made as before described, the hole being formed of two hollow cones, meeting each other at their apexes.

When the thin slip of ruby has been drilled, as above described, it is fixed on a fine steel arbor, as seen in fig. 4, where it has its external edge turned perfectly true, by a piece of diamond *bort* with a sharp edge to it, and which is soldered or cemented to the end of a suitable piece of steel or iron wire; and when so turned, it is fit to be fixed in a small brass ring or setting, if for a clock; but if it is for a watch, a proper recess is made for it in the cock, dovetail, or other part to which it is to be applied; and it is held fast by very delicate screws, the heads of which are broad enough to secure it by pressing upon its edge. Fig. 9 shows a section of a ruby hole, upon an enlarged scale. In this figure the double conical form of the drilled hole will be plainly seen. But as the mode of drilling above described leaves the surface of the hole *grey*, it is afterwards polished, by means of a fine piece of steel wire, charged with diamond powder of the finest sort, and applied while the stone is turning rapidly in the lathe. In order to facilitate the process of polishing the holes, the stone is turned so as to fit a small recess formed in a chuck, where it is held by friction; and when one side, or hollow cone, is polished, the ruby is reversed in the chuck, and then the other side, or hollow cone, is polished also.

When perfectly cylindrical holes are required, then a very fine-tempered steel wire is to be fixed in a chuck, as seen at fig. 4; and the stone to be drilled is first marked, or slightly punctured, with a diamond drill, and then the fine steel wire being supplied with fine *bort*, a cylindrical hole will soon be made, by the rapid motion of the steel wire, the point of it being repeatedly charged afresh with the *bort*. The polishing of the hole is effected in the way above described, namely, with fine diamond powder.

Fig. 10 shows a section of a ruby pivot hole, upon the same magnified scale, placed in a recess formed for it in the cock of a watch, a fragment of the cock being seen at *c c*; *d* is the diamond, or ornamental stone, cemented in a steel ring, upon which the screws *e e* take a bearing, and thus confine the ruby hole firmly in its place. The pivot, with a fragment of its arbor, is seen at E.

Fig. 11 represents one of the diamond drills, upon a magnified scale, the piece of diamond, cemented to the end of the wire, being so small as not to be seen with the naked eye, if it were shown of the real size. Other larger rhomboidal splinters of diamond, however, are also shown in this figure.

Fig. 12 is an edge view of one of the metal mills, or laps, used for reducing the slips of ruby to a flat surface, when the face of the mill is charged with powdered *bort*. *Hard brass* is most commonly used to be charged with *bort*, and *copper* for polishing with the fine *diamond powder*.

In the variety of escapements applied to clocks, watches, and chronometers, there are frequently parts that require the application of rubies, or other hard stones, to prevent the abrasion or reduction of the surfaces that must otherwise take place, from the wear that is inevitable in such delicate pieces of machinery. It is mostly in the case of the pallets that such additions are necessary. These are generally made with surfaces, which are either flat, or portions of cylinders.

Fig. 13 shows, upon a magnified scale, a pallet, formed of a flat slip of ruby or other hard stone; the upper and lower edges or faces of it are made cylindrical. If the piece of ruby is very small, it may be reduced to flatness on one side, by cementing it to a small plate of steel, which has a minute conical hole made through it, as shown in the plan of both sides of it, and also in the edge view of it, in fig. 14. When the stone is cemented to the steel plate exactly in the centre, a small quantity of powdered *bort* and olive oil is laid on the surface of a piece of flat ground plate glass; and the stone being laid on it, a small steel point is pressed into the conical hole in the steel plate, and which thus forms a very simple kind of *universal-joint*, that will enable the workman to produce one flat face upon the piece of stone cemented to the steel plate, if he rubs it in a circular direction on the surface of the piece of plate glass, while the steel point placed in the minute conical hole is kept nearly perpendicular.

As this produces a *grey* surface, a *fine polish* may afterwards be given to the stone, by rubbing it on a surface of copper, with fine diamond powder. But where the surfaces are not to be submitted to the action of attrition, it is useless to polish them so highly.

I shall now call the attention of your readers to the methods adopted to form and polish the cylindrical surfaces of the acting parts of clock or watch pallets.

Fig. 6 shows a plan, and side elevation, of a chuck or tool for forming cylindrical surfaces, both internal and external. Fig. 7 is a section, through the centre of it. The small screw, seen in the elevation and section, is that which fixes it in the screwed hole made to receive it in the mandrel of the lathe. The projecting cylindrical rim, or ring, *f*, is the part that is used, when charged with *bort*, to produce the cylindrical faces upon the pallets before named; *g* is a small tempered steel pin, or axis, made fast in the chuck to receive a small sliding tool, to which the pallet is fixed by cement. Fig. 15 represents a front elevation, and fig. 16 a side view, of the sliding tool complete. Fig. 17 shows a front elevation of it, with a pallet cemented to it, in a position to have a cylindrical surface formed on its under edge, as shown at *h*. Fig. 18 is a stud or collet, having a fine hole through its centre, which fits upon the small steel pin *g*, seen in figures 6 and 7. Fig. 19 is a stud that screws upon the tapped end of fig. 18, and permits the forked plate *i*, as seen in figures 15 and 16, to slide freely between them.

When the ruby pallet is cemented properly, as shown in fig. 17, the collet, and its sliding forked plate, is placed on the pin *g*, fig. 6, when the pallet must be pressed down upon the rim, or projecting ring of the chuck *f*, by holding the small wire handle F between the fore finger and the thumb; and as the rim or ring is charged with *bort*, or diamond powder, as the case may require, the curve produced will be a portion of the circle shown at *f*, and which may be varied at pleasure, by using either a larger or a smaller ring.

When external curves are requisite, the piece of ruby should be fixed by cement to the upper end of the forked plate, as shown in fig. 15, and in this state it can be applied to the internal surface of the ring *f*, fig. 6; and, consequently, an external curved surface will be produced, which may, of course, be varied by using a ring on the chuck, of smaller or larger dimensions.

I shall here observe, that it is always requisite to make a model of the pallet in brass first, and when its true shape has been most accurately determined, then the ruby is to be made a *fac simile* of it, and cemented into the cavity formed for it, in the usual manner. It may also

also be necessary to observe, that I do not mean, in this article, to enter into a full detail of the *particular niceties* of watch and clock jewelling; my intent being merely to give a few hints relative to the use of the diamond, in this delicate and useful art.

(*To be continued.*)

XXXV.—*Observations relative to some of the Mountain Districts of Pennsylvania, and the Mineral Resources of that State, in its Anthracite, Bituminous Coal, Salt, and Iron, with Miscellaneous Remarks. By* JAMES PIERCE*.

A CONSIDERABLE proportion of the state of Pennsylvania is occupied by mountains, generally uninviting to the settler, and mostly remains in a state of nature. It is crossed by the Blue Ridge, Alleghany, numerous minor ridges, and extensive tracts of elevated table land, that spread over an average width of 150 miles. Though undesirable for agriculture, much of this mountain region contains, in its anthracite, bituminous coal, salt, and iron, mineral treasures that will be a source of inexhaustible wealth to the state.

In no part of the world is *anthracite, so valuable in the arts and for economical purposes,* found as abundantly as in Pennsylvania. Its cheap diffusion will be of incalculable advantage to the Atlantic States, where the increased expense of fuel begins to be felt; and its further enhancement would limit the population, and materially interfere with the progress of manufactures. To agriculture it will be a material auxiliary: fuel being supplied from the interior of the earth, the surface can be more extensively cleared and cultivated; and wherever our numerous calcareous valleys are intersected by canals and navigable streams,

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* From Professor Silliman's *American Journal of Science and Arts.* This article is of so great interest, that we have preferred to give it entire, long as it is.—EDITOR.

lime, so valuable as a manure, and in the arts, can be calcined at a low rate, by the aid of anthracite. Experience has demonstrated, that *for the manufacture of iron this fuel is peculiarly advantageous*, as it embraces little sulphur, or other injurious ingredients; produces an intense steady heat; and, for most operations, it is equal, if not superior, to coke. Bar iron, anchors, chains, steam-boat machinery, and wrought-iron of every description, has more tenacity and malleability, with less waste of metal, when fabricated by anthracite, than by the aid of bituminous coal, or charcoal, with the important additional advantage of a diminution of expense, at least fifty per cent., in labour and fuel; and iron castings are stronger when the melting has been effected by the aid of anthracite. Possibly, in the quick process of heating and fusing, it communicates less carbon and oxygen. For breweries, distilleries, and the raising of steam, anthracite coal is decidedly preferable to bituminous coal, or other fuel, the heat being more steady and manageable, and the boilers less corroded by sulphureous acid, while no bad effects are produced by smoke and bitumen.

The anthracite of Pennsylvania is located between the Blue Ridge and the Susquehanna, and has not hitherto been found in other parts of the state, except in the valley of Wyoming.

The anthracite district is principally occupied by mountains running parallel to the Blue Ridge, often broad, with table land summits, and rising generally about 1500 feet above the ocean. With the exception of a few narrow valleys, this region has little surface inviting cultivation. The summits, by repeated fires, have been divested of much timber, leaving, thinly scattered, pitch and yellow pine, and white oak, and are generally too stony for tillage; but they may, at some future period, afford good ranges for cattle and sheep. In an extensive elevated valley, bordering upon the head waters of the Lehigh, there is much land clothed with a dense forest of beech, hemlock, maple, birch, &c., with a good soil for grazing. The anthracite mountains, and ranges connected with them, are mostly in a state of nature, and afford retreats for wolves, panthers, bears, deer, and other animals resident in the unsettled parts of our country. In passing from the Berwick turnpike road to Wilkesbarre, in a distance of thirty-five miles, I noticed but three dwellings, and two of these were log taverns lately erected. Between twenty and thirty panthers have been killed, within three years, by the hunters of Lowrytown, a settlement recently founded on the Lehigh.

The rocks of the above described region are of the transition class, and present little diversity, being principally grey wacke slate, which occurs in abundance, loose, on the surface and in ledges. It is sometimes based on old red sand stone, and surmounted by an unstratified rock, an aggregate of quartz pebbles of various dimensions, with a cement principally silicious. In the Blue Ridge, in addition to the above described rock, a silicious grey wacke, resembling fine grained granular quartz, is common. It appears in some places massive, but is often slaty. Its cement is merely silicious; some alumine, however, is indicated in its composition.

The beds and veins of anthracite range from north-east to south-west, and may often be traced for a considerable distance by the compass. The veins have the inclination of the adjacent strata of grey wacke, with which they often alternate, usually between 20° and 45°. In a few places they are horizontal and vertical. The beds and veins of anthracite have narrow strata of dark-coloured, fine-grained, argillaceous schist, for the roof and floor. This slate generally contains sulphuret of iron, and disintegrates on exposure to the air. The sulphates of alum and alumine are often observed in the schist, and it frequently presents impressions of plants, and sometimes of marine shells. Impure pulverulent coal is usually connected with this slate, and it is said to be a good material for printers' ink.

Anthracite has been found in the greatest quantity in sections of the coal region most accessible by water. Extensive veins and beds range from the Lehigh to the Susquehanna, crossing the head waters of the Schuylkill and Swatara, about ten miles north-west of the Blue Ridge, and it abounds contiguous to the Susquehanna and Lackawanna. But in no part of the district does anthracite occur in such apparent inexhaustible beds, or is so abundantly raised, as in the vicinity of Mauch Chunk, a village situated on the Lehigh, thirty-five miles from Easton, and one hundred and eight, by water, from Philadelphia.

The coal is there excavated on the flatsummit of the mountain that rises near 1500 feet above the ocean. It is of good quality, and presents beds of unparalleled extent; is disclosed for several miles on the summit, wherever excavations have been made, and is indicated in many places by coal slate, in a pulverulent state, on the surface. The mountain rises with steep acclivity, particularly on the north-west side, and when penetrated at various altitudes, discloses coal at about the same distance from the surface. Strata of grey wacke slate, containing mica, sometimes rest on the coal, parallel with the mountain side. In the deep excavations made on the summit, no termination of coal bed has been found, and it is not improbable that anthracite forms the nucleus of the mountain for a considerable distance.

The coal is rendered accessible by removing from the flat summit gravelly loam, which is from a few inches to four feet in depth, and disintegrated slate, with impure coal, from two to four feet. The coal rests in a horizontal position, narrow parallel seams of argillaceous schist intervening. This schist exhibits saline efflorescences. Strong chalybeate springs, holding in solution sulphate of iron, issue from the mountain's side. The coal excavation on the surface is extensive, and from thirty to forty feet in depth, forming a hollow square, bounded by lofty mural precipices of coal. Waggons are admitted by avenues that serve to discharge water from the mine. The coal is easily detached by picks and bars. From this bed, in 1825, about 750,000 bushels of coal were sent to Philadelphia, and it is expected that a million of bushels will be forwarded the current year. The expense of raising coal is forty cents the ton.

The coal mountain range is reported as extending in a south-west direction to the Susquehanna. To the north-east, beyond the Lehigh, it is connected with Broad Mountain, the first considerable elevation west of the Blue Ridge, or Kittetany mountain, as it is sometimes called.

Rocks in place rarely occur on the table land summit, adjacent to the coal bed. Old red sand stone exists in places near the mountain's base, with superincumbent strata of grey wacke slate, and silicious aggregate of quartz pebbles, resembling the mill-stone quarries of the Shawangunk mountain, which probably may be put to the same use.

About ten miles of the coal mountain, the village of Mauch Chunk, and an extensive tract adjacent to the Lehigh, are the property of a company having a capital of a million of dollars, incorporated by the legislature of Pennsylvania. They have constructed a good turnpike, that rises gradually 936 feet in nine miles, the distance between Mauch Chunk and the coal bed. The coast of transportation by this road is sixty cents the ton; about seven tons are conveyed with ease on two waggons, drawn by four horses.

A railway has been surveyed on the mountain's side to the coal bed*. It will be single, with places for turning out, and terminates near the Lehigh, at an elevation of about 200 feet above its level. The coal, in its descent from thence to the yard, or boats, can be riddled of earth and fine particles. Iron waggons, carrying three tons of coal, will descend on the railway, by their own gravity, regulated by a piston connected with the wheels, and working in a horizontal cylinder with valves and stopcocks. The resistance of air or water in the cylinder will be sufficient to retard or arrest the waggons in their course*.

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* Now completed; see an extract from a letter from Erskine Hazard, Esq., to Jacob Perkins, Esq., civil engineer, in our last number, p. 123.—Editor.

It is calculated that the expense of transportation on the railway will not exceed twenty-five cents the ton.

The Lehigh company are endeavouring to procure coal two miles and a half from Mauch Chunk, by tunnelling 200 feet below the precipitous ridge, that occupies the eastern brow of the coal mountain. The excavation, of a sufficient magnitude for the passage of teams, has been extended more than 600 feet in a hard rock of quartz pebbles, without finding coal. Twelve workmen are constantly employed, and have advanced about a foot each day. Shafts have been sunk sixty feet in the table land, at the base of the narrow rocky ridge: good coal was found after penetrating seven feet of earth and slate. The bottom of the shaft is supposed to be eighty feet above the tunnel. If no coal is struck in proceeding horizontally, the tunnel will still be serviceable for discharging water from the great coal bed above, and to receive coal from that bed which may extend to within a short distance of the excavation, and can be worked in horizontal galleries. The sides of the ridge, above the tunnel, are too precipitous for the passage of waggons. The elevated summit of the ridge commands a view of many wild, rocky, wood-clad ranges, and deep ravines.

The improvement of the navigation of the Lehigh is one of the conditions annexed to the charter of the company: this has already been effected in respect to a descending navigation from Mauch Chunk to the Delaware, and further improvements for an ascending navigation, and to extend the water communication up the river to Stoddartsville, are in progress. The Lehigh is a copious rapid stream, that has its origin among wood-clad rocky mountains, forty miles north-west of Mauch Chunk. Its waters are pure, and well stored with trout, pike, sunfish, catfish, eels, perch, and other fish. There is much good pine and other timber adjacent to the Lehigh, eighteen miles above Mauch Chunk, much of which is the property of the company, who have formed a settlement for cutting and rafting timber, at which they employ 150 men. The descent from Stoddartsville to Mauch Chunk is 925 feet, and for the effectual improvement of the navigation, thirty-eight large dams will be required. They will afford valuable sites for mills and manufactures. When the contemplated improvements are effected, the Lehigh will be navigable within twelve miles of the rich valley of Wyoming, and much of the wheat of that section of country, which is now transported sixty miles to Easton, may find a readier market on the Lehigh. The descent from Mauch Chunk to Easton is 364 feet, to overcome which, it is calculated that 21 dams and 52 locks will be necessary. Many dams have been already constructed of pine trees, at an expense of about three thousand dollars each. They are placed at the heads of rapids, enabling the navigator to command an artificial flood, when the stream, from its dispersion, would not otherwise admit of the passage of boats. Water from the dam is copiously admitted into the sluice that extends to the foot of the rapid. The gates, in the lock at the head of the sluice, of peculiar construction, were invented by one of the managers, Mr. White, to whom the company are indebted for many ingenious improvements. The gates are attached by hinges to the bottom of the lock, and rise by the force of water admitted from a culvert constructed parallel with the lock, and remain suspended, forming a section of the dam. If the gate of the culvert is closed, the water between the gates passes off, and they fall by their own weight and the pressure of the water from the dam. To facilitate an ascending navigation, short canals to the termination of the rapids will be required. A canal of a mile and a quarter, commencing at Mauch Chunk, has recently been excavated: the locks are of the new construction above mentioned.

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* A similar contrivance has been applied to cranes in this country, by Mr. David Hardie.—Editor.

The Lehigh, from Mauch Chunk to the water gap, eleven miles, winds between rocky mountains, with a brisk current, but presents no falls. The road usually runs near the stream, and sometimes at a considerable elevation above, on the steep mountain's side. In its passage through the Kittetany, or Blue Ridge, the river has a pretty tranquil and but slightly inclined course. On the adjacent elevation, yellow pine, hemlock, and spruce firs, are interspersed with trees of annual verdure. From the water gap to the Delaware, the river pursues its course in a deep ravine, with rarely alluvial borders of much extent, and is seldom seen from the road. The soil in this district of country generally rests on limestone sinks, indicating caves, and fissures in the rocks are often observed, and will render canal making in places difficult. From the confluence of the Lehigh with the Delaware to tide water, the descent is 150 feet. The rapids of the Delaware, in dry seasons, present great impediments to forwarding coal. A canal will probably be found indispensable to secure a permanent ascending and descending navigation of this stream. Boats are rarely lost in the descent.

Coal is conveyed to market from Mauch Chunk landing in flat bottomed shallow boats, twelve feet wide by sixteen in length, connected by hinges, and denominated boats in section. Six or seven of these boats, each laden with ten tons, are usually united, and are navigated to the Delaware by four hands: from thence to Trenton five are required. Six days are commonly occupied in the descent to tide water, and in the return. The boats are disposed of for lumber. The construction of the boats, independent of materials, costs sixty cents each. If formed of pine plank, they are probably disposed of without loss, when the navigation is completed. The boats can be conducted by small steam-vessels, and returned, producing an important saving. At present, the expense of raising and transmitting coal from the Lehigh beds to market, is less than from any part of the coal regions. It does not exceed two dollars the ton of twenty-eight bushels, and will be materially lessened by the construction of canals and railways. If, as is probable, the price in Philadelphia should, under competition, be reduced to four or five dollars, this coal trade will still afford a large profit on the capital employed. When the numerous canals connecting the extensive coal region of Pennsylvania with the navigable waters of the sea-board shall be accomplished, coal will be far the most economical fuel for our commercial towns, and parts accessible by water. In large cities, it will be peculiarly valuable from its safety, and may save considerable expense in the construction of dwellings. By adopting stove furnaces and pipes, they can dispense with chimnies and fire-places, and the removal of soot and obstructions by sweeping will not be required.

In the valley of the Delaware, which in the latitude of Easton has a width of thirty miles, presenting a rich soil, with a calcareous basis, anthracite will be of great utility, from the low rate at which it can be afforded, superseding the necessity of retaining groves for fuel, now frequent on superior arable land, and will enable the manufacturer of lime to furnish that valuable manure at a very low rate. It is now calcined in kilns, which may be continued in use without intermission, at the cost of two cents the bushel, by the aid of anthracite. From twenty to thirty bushels of lime can, in ordinary kilns, be daily subtracted from below.

The village of Mauch Chunk is situated on the western bank of the Lehigh, in a deep romantic ravine, between rocky mountains, that rise in some parts precipitously to 800 or 1000 feet above the stream. Space was procured for dwellings by breaking down the adjacent rocks, and by filling a part of the ravine of the Mauch Chunk creek.

A portion of this stream has been transferred to an elevated channel, and is used to propel a grist mill. Within six years the Lehigh company have erected, and are the proprietors of about 120 dwellings and buildings of every description, including a large hotel, a store, two furnaces, a grist mill, and several saw mills: about 800 men are employed by the company. Stricter moral obligations are here subscribed to and observed, than could be enforced by a state, or the general government, as the penalty of violation is dismissal, without reprieve, from a very desirable service, and the ejectment of tenants at will from their dwellings.

Tippling houses, and the retail of ardent spirits, are not tolerated. There is but one tavern and store in the village, and they are owned by and under the control of the company. Drunkards are not suffered to remain. Abuse or neglect of their families, and cruelty to cattle, are grounds of dismissal. There is no regular place of worship, but clergymen of every denomination are invited to preach, and dissipation is prohibited on the sabbath. By a small annual contribution from each workman, and heads of families in the village, an able physician is procured, who attends the sick without further compensation.

Labourers, in the employment of the company, are furnished with daily rations of whisky— a practice to be deprecated, as inducing habits of intemperence. Beer should be substituted, as was once contemplated. More than an equivalent in money is now offered to those who abstain from ardent spirits, so unnecessary for the performance of labour, which considerably enhances the receipts of those who accept of the terms.

The company have a small furnace in operation, which produces daily about 3500 pounds of castings. The ore used is of good quality, procured twenty miles below, near the Lehigh. A ton of coal is exchanged at the furnace for the same weight of ore. Limestone, necessary for a flux, is furnished at the same rate. A third part of bog ore, found near the village, is mixed with the purchased ore. The head workman informed me, that *by blending a tenth part of pounded anthracite with charcoal, in smelting, a third more work is done in a given time* than would be produced by charcoal alone. Pigs are melted for castings entirely by *pounded anthracite,* producing better casting and great diminution of labour. A stronger blast, however, is necessary for anthracite, than is required for charcoal. Sledge hammers, cast from meltings by anthracite, have been found sufficiently strong to be useful. The coal is pounded in a water mill. A large furnace has recently been erected by the company, where castings for the railway will shortly be produced.

Several bodies of anthracite occur north-west from the coal beds of the Lehigh company, and about eleven miles from Mauch Chunk. The most extensive is situated in the Beaver meadow, south of the Berwick turnpike. It has been ascertained to be more than fifty feet in thickness, and of a quality equal, if not superior to the Lehigh company's. A considerable quantity has been raised this season, and conveyed to the Lehigh for shipment. By a railroad, this coal may be brought at a moderate expense to navigable waters, and be productive.

In travelling north from the Berwick turnpike, I ascertained, that veins of coal range in a northern direction from the Beaver meadow for many miles. One was mentioned as existing three miles from Lowry town.

Coal has not yet been discoved in Pennsylvania to the north-west of the Lehigh; but as it is an unexplored region of the same geological character, rocks, &c., with the anthracite district, it is not improbable that it may be discovered in that direction, and it is rendered more probable by the existence of narrow veins of anthracite in the gray wacke eminences of Sullivan and Ulster in the State of New York, connecting the Catskill mountains with the anthracite ranges of Pennsylvania. With the exception of a vein of anthracite, said to have been recently discovered in the Delaware water gap, that mineral does not occur within ten miles of the Blue or Kittetany mountains, or of the Shawangunk, a part of the same chain, and which presents similar rocks.

From the principal coal bed of the Lehigh Company, to a considerable branch of the Schuylkill, the distance is but three miles. The navigation of this stream is susceptible of improvement, and may, at a future period, be the medium of conveyance of coal found on its borders.

Between Mauch Chunk coal bed and Mount Carbon, a distance of eighteen miles, veins of coal running in a south-west direction occur. It is mountainous, unsettled, and but little known.

Next to Mauch Chunk, Mount Carbon, or Pottsville, as it is now called, situated at the head of the Schuykill canal, has been the principal source of the supply of anthracite. Many large veins are worked within three miles of the landing; and some have been opened seven miles to the north-east, in the direction of the Lehigh beds. The chief veins wrought are, one situated on an eminence, adjacent to the village; Bailey's mine, about two miles from Pottsville, and near the turnpike to Lunbury, and on the turnpike to New York Schuykill coal company, about three miles from the village. On almost every eminence adjacent to Pottsville, indications of coal are disclosed. The veins generally run in a north-east direction, with an inclination of about forty-five degrees, and are from three to nine feet in thickness. Commencing at or near the surface, they penetrate to an unknown depth, and can often be traced on hills for a considerable distance, by boring, in a north-east or south-west direction. Some veins have been wrought to the depth of two hundred feet without a necessity of draining, the inclined slate roof shielding them from water. Where the ground admits, it is considered the best mode of working veins to commence at the back of a coal eminence, or as low as possible, and work up, filling the excavation with slate and fine coal, leaving a horizontal passage for the coal barrows. A section of a wide vein near Pottsville has been wrought by this mode several hundred feet into the hill. The same vein is explored from parts of the summit by vertical and inclined shafts. The coal and slate handled are raised by horse power, in waggons, by a railway that has the inclination of the vein. Veins of coal alternate with gray wacke slate in the hill. Vegetable impressions sometimes occur in the argillaceous schist that forms the roof of the Pottsville coal veins.

On the extensive tract occupied by the New York company, coal is reported as inexhaustible. I was informed by the company's superintendant at Pottsville (Mr. Baker), that coal beds, from forty to one hundred and fifty yards in width, are there indicated by coal slate; good coal is found in boring between the layers of slate; but they have not been much explored; in one or two places veins in vertical and horizontal positions occur; but they have generally, on the lands of the company, the usual inclination and direction. About three hundred men are employed by this company.

It is contemplated to render a western branch of the Schuylkill navigable, which will give easy access to a large body of coal, the property of the New York company, situated five miles from Pottsville.

Coal at the head of the canal is sold for ten cents the bushel. The raising costs about three, and cartage a cent a mile; the canal tolls amount to about five cents and a half, and freight near four, making the whole expense from the mine to Philadelphia from four dollars to four and a half the ton, according to the location of the coal bed, or economy used. A considerable saving in the item of cartage would be effected by the formation of railways to the principal mines. They are generally situated considerably above the landing, and present a descent most of the way to the coal yards. It is probable that there will be a further extension of the canal into the coal region, which with the formation of railways will give access to coal beds otherwise too remote for profitable working.

Should it be found necessary, to enable the proprietors of coal beds at Pottsville to come in competition in the market with coal from other localities delivered at a cheaper rate, the canal company will find it for their interest to lower the rate of toll, and would be compensated by an increased quantity shipped.

From Pottsville to Philadelphia, a distance of 132 miles, the descent is 588 feet. The navigation of the Schuylkill is improved by alternate dams and canals. Between the coal mountains and the Blue Ridge, the canal passes through a wide, extensive, elevated, and very broken valley, of a generally poor soil, partially cultivated, and thinly occupied by inhabitants of German descent, who speak the language of their ancestors. It was represented that not one in ten could converse in English. There is a narrow range of limestone in parts of this valley, adjacent to the Blue Ridge.

The passage of the Schuylkill and canal through the Blue Ridge is interesting. The mountains bordering the ravine are lofty and precipitous, presenting ledges of old red sand stone, with coarse and fine silicious gray wacke. The turnpike road winds on the mountain's side at a considerable elevation above the stream. The navigation through the pass is effected by stone dams of magnitude, and permanent construction; one of them is of thirty feet altitude. Groups of locks, water falls, and broad sheets of water, were frequent. The expense of lockage would here have been considerably lessened by adopting the inclined plane. From the Blue Ridge the Schuylkill, for forty or fifty miles, winds through a valley in which there is limestone, the fissures and cavities of which in some places rendered the formation of a canal difficult. I noticed four miles from Reading, and not far from the river, extensive beds of rock, closely resembling in composition and colours the calcareous breccia of which the columns in the capitol at Washington are formed.

The navigation of the Schuylkill has been much interrupted by droughts the past season, and frequent repairs required. Boats have often grounded in the shallow water of dams. It will probably be found advisable to concentrate the water in a canal for most of the distance. Fevers, so generally prevalent within a few years in the valley of the Schuylkill, have been attributed by some to water stagnating in the dams.

The village of Pottsville, of recent origin, contains several good stone dwellings and stores. A weekly journal, edited with ability, is here published. A reading room, containing many books and periodical publications, does much credit to the village.

Beds and veins of coal occur in numerous places between Pottsville and the Susquehanna, and are found on the side of Broad mountain, a central elevation. Mines are opened and worked at the head waters of the Swatara and Stony creek, at Peters' mountain, and a few miles east of Danville.

South-west of Pottsville the coal becomes more easily ignited, and that at Peters' mountain is reported to contain bitumen. It is probable that the coal of that vicinity embraces, like the Wilkesbarre, much more inflammable gas than the Lehigh, which may have led to the supposition that it was bituminous.

The coal from this part of the state can be forwarded to Philadelphia by the aid of railways, and lateral canals communicating with the Union Canal, which runs through a fertile limestone valley, in a parallel course, and at no great distance from the coal hills.

Anthracite is found on several of the streams that discharge into the Susquehanna, on its eastern side. A large bed, not yet epened, exists a few miles eastwardly from Berwick, and numerous veins occur from an elevated part of the Wilkesbarre mountain, to the Kingston and Shawnese mountains, that form the western border of the basin of Wyoming. No anthracite has been discovered to the west of these mountains, or north of the Lackawanna range, with which they are connected.

Veins of coal in the vale of Wyoming are not only very numerous, occurring on almost every farm, but many are of uncommon thickness, in some instances from eighteen to thirty-five feet; and the vegetable impressions are far more abundant and diversified than were elsewhere observed. At Bowman's, one of the most considerable mines now worked, they are particularly numerous, pervading the superincumbent strata. The vein is about eighteen feet thick, and wrought in galleries. The coal, which is very compact, is detached by blasts. The inclination of the vein is about one foot in four.

There is less uniformity in the angle of inclination and direction of the coal strata in this neighbourhood, than was observed near the Schuylkill. They approach nearer to the horizontal.

From the abundance of sulphuret of iron in the slate contiguous to, and dividing coal veins, the springs proceeding from the coal beds and the Susquehanna are strongly impregnated with salts. These mineral waters often occur, in both mountain and valley, and indicate beds of coal.

A canal route has recently been surveyed by state commissioners, and carried through the valley of Wyoming, on rising ground west of the Susquehanna. When the work is accomplished it will lessen the charge of forwarding coal to market from this vicinity, and the valley of the Lackawanna. From Wilkesbarre to the Chesapeake, the descent is about 500 feet. By the hazardous and precarious medium of the Susquehanna, coal cannot now be conveyed in arks for less than three dollars and a half the ton, which, with other charges, makes the expense to the mouth of the river five dollars the ton. The Philadelphia market may be resorted to through the medium of the Union Canal. A canal to connect the Susquehanna with the Lehigh is practicable. The distance to Philadelphia, by this route, from Wilkesbarre, is 162 miles; and the lockage required, 1279 feet.

The coal of the Susquehanna is readily kindled in grates of ordinary construction; and by the experiments recorded in No. 2, Vol. X. of the Journal of Science, it has been ascertained, by the editor, to contain double the quantity of hydrogen gas contained in the anthracites of the Lehigh and Schuylkill, and in bituminous coal, an important characteristic not before suspected. The valley of Wyoming, and its valuable beds and veins of coal, have been correctly described in No. I. Vol. IV. of the Journal of Science, by Mr. Z. Cist, an able naturalist, whose recent death is lamented by all acquainted with his merit.

I visited several large coal beds and veins in the valley of the Lackawanna; they run in a north-east course; some were wide, and the coal is of a good quality. Coal veins are of frequent occurrence from the confluence of the Lackawanna with the Susquehanna to near the head waters of the former river; they are variously inclined, from nearly horizontal to an angle of forty-five degrees. Vegetable impressions are rarely, if ever, contained in the coal slate of these beds and veins.

The most considerable body of coal in this region is situated between twenty and thirty miles from the Susquehanna, at the ragged islands, in a narrow valley, adjacent to the Lackawanna, and in the bed of that stream, which washes the southern base of the Lackawanna mountain, a lofty, rocky chain, that bounds the partially cleared valley of the Lackawanna to the north-west. This mountain is well clothed with trees of diversified verdure. Good pine, and much heavy timber, principally hemlock, maple, beech, and birch, is found near its base, and adjacent to the upper part of the river.

This coal bed, supposed to be very extensive, is the property of the Hudson and Delaware canal and coal company, and has been penetrated thirty feet without finding the termination of the coal. From this bed, which rests in nearly a horizontal position, a considerable quantity of excellent coal has been raised, but from its low situation the excavation was soon filled with water. It has been occasionally cleared by pumps propelled by water. It is supposed that there is sufficient descent of ground to free it by draining. The quarrying may perhaps be interrupted by floods. I observed on the south bank of the river a wide vein of coal, which rises above the stream with sufficient inclination to run galleries clear of the water. A large tract on the side of the mountain that ascends gradually to the east from the coal bed, has been cleared at the expence of the company, and a village will shortly arise. Coal beds extend several miles higher up the stream. In value, and good quality, the Lackawanna anthracite may be advantageously compared with that of the Lehigh. The coal of this region will be conveyed to New York, a distance of 217 miles, through the medium of a canal now constructing under the able superintendance of Judge Wright, by the proprietors of the coal bed. This canal commences at the Hudson, near Kingston, and passes to the Delaware, sixty-seven miles, through a valley located between the Shawangunk mountain, and the gray wacke ranges, spurs from the Catskills. Except near the Delaware, and on approaching the Hudson, where considerable excavations in limestone and other rocks became necessary, there was little difficulty in constructing the work, as for much of the distance it passess through sandy and gravelly loam. For twenty miles it runs on the side of a mountain north of the valley, and at a considerable elevation. At the summit level the canal extends eighteen miles without a lock. It will probably be completed from the Hudson to the Delaware the present season.

Beds of dark argillaceous schist, of small extent, are in a few places cut through. Limestone, of a good quality for calcining, occurs at the base and in places on the side of the Shawangunk ridge, adjacent to the canal in approaching the Hudson and Delaware, and will be useful to the part of Pennsylvania situated between the Delaware and Susquehanna, in which there is no limestone. The construction of the canal up the Delaware, on its eastern bank to the Lackawaxen, a distance of twenty miles, will be arduous and expensive. For several miles it is carried on the steep rocky side of a mountain. The passage up the valley of the Lackawaxen will be comparatively easy. Parts of this valley are settled, and contain much alluvial land. About one thousand feet of lockage are required from the Hudson to the western termination of the canal. The coal bed is to be connected with the canal by a railway of a few miles, passing over a considerable eminence. Lumber and coal will for many years be the principal articles transported down the canal. An extension of canal navigation up the Delaware into the State of New York, which is practicable, would enhance the value of the stock. The rates of toll demanded for coal, will, if maintained, exclude individuals from participating in the coal trade through the medium of this canal. The canal will communicate with a large tract of good grazing land in Wayne county, a part of the district called the beech-woods, that extends in Pennsylvania and New York about one hundred miles from north to south, and from ten to fifty miles in breadth. It is heavily timbered, principally with beech, maple, hemlock, and birch, with occasional groves of good pine. The soil, often based on hard pan, is tenacious of manure and moisture, and good for grazing and tillage. Its surface is undulating, but rarely mountainous; and a considerable proportion is sufficiently free from stone for the purposes of agriculture. Viewed from the eastern brow of an elevated range, situated between the Lackawaxen and Lackawanna, this tract of country had the aspect of an immense plain; its dense forest was dressed in the gay hues of autumn, blended with the perennial verdure of pine and hemlock. The blue peaks of the Catskill mountains to the north-east, towering far above the general elevation, presented an irregular profile on the verge of the horizon. To the east, beyond the fire-seared, barren, rocky ranges of Pike county, the Sawangunk and Highland ranges were distinguished. Emigrants from New England are busily occupied in cutting out farms in the beech woods. The first clearing is a work of toil; but, as there are no sprouts from roots, less labour is eventually required than to subdue some descriptions of oak land. From the little durability of hemlock, beech, and maple, in fencing, it may in time be necessary to substitute the loose gray wacke slate of the surface. Old red sand occurs in the gray wacke region, and often supports a good soil. Flocks of sheep may here be advantageously introduced. Through the medium of the canal, the farmers of Wayne and other counties can be amply furnished with lime and gypsum, so useful in agriculture.

The western part of Pennsylvania is abundantly supplied with bituminous coal, as the eastern is with anthracite. It is found on the rivers Conemaugh, Alleghany, and Monongahela, and in numerous places to the west of the Alleghany ridge, which is in general its eastern boundary. It occurs on this mountain at a considerable elevation, and elsewhere, in nearly a horizontal position, alternating with gray sand-stone, that is often micaceous and bordered by argillaceous schist. The veins are generally narrow, rarely above six feet in width. This mineral is abundant, and of very good quality near Pittsburgh, where it is valuable for their extensive manufactures. Beds of bituminous coal are reported as occurring in Bedford county, in the north-west part of Luzerne, and in Bradford county. In this last county, nine miles from the Susquehanna, there is an extensive bed of coal, regarded as bituminous. It has been penetrated thirty feet without fathoming the depth of the strata.

Bituminous coal is abundant in Tioga county, state of New York, adjacent to the route of a feeder required for a canal contemplated, to connect the Susquehanna with the Seneca lake. The summit level is forty-four feet above the river, and upwards of four hundred above the lake. It occurs on the Tioga, and on the Chemung, a branch of that river. When the canal communication is effected, the interchange of anthracite and bituminous coal for salt and gypsum will be highly valuable for Pennsylvania and New York.

Bituminous coal exists on the Loyal Sock and other streams that descend the western side of the extensive peninsula, situated between the north and west branches of the Susquehanna.

The centre and northern part of this section of the state is elevated, and mostly in a state of nature. It is crossed by barren ranges, interspersed with valleys and well timbered table land, which will in time be occupied for grazing and tillage. The rocks of the eastern part that fell under my observation are transition, mostly gray wacke slate. In the western part, adjacent to the west branch of the Susquehanna, limestone is the predominant rock.

This stream, for near fifty miles, winds with a moderate current through a rich valley, with wide alluvial borders often occurring. The valley is bounded to the south by the Bald Eagle mountain, an extensive elevated rocky range.

Springs, holding in solution muriate of soda, are common in various parts of the bituminous coal region; they are generally weak near the surface, but deep springs, disclosed by boring, are often strong. One, containing as much salt as the ordinary waters of Salina, has recently been discovered, by boring, about twenty miles from Montrose, bordering on the state of New York. They occur in some of the southern counties of that state, adjacent to Pennsylvania, and on the Loyal Sock and other streams, auxiliary to the west branch of the Susquehanna.

But the most productive saline springs of Pennsylvania are situated on the banks of the rivers Conemaugh and Kiskaminitas, about thirty miles east of Pittsburgh. These rivers for many miles wind rapidly through rocky romantic ravines, bordered by hills of from three to four hundred feet elevation, that rise with steep acclivities, presenting mural and projecting precipices of gray sand-stone, in places jutting over the road and torrent. The sand-stone is ordinarily fine, but is sometimes a coarse aggregate, principally quartz. Its thin laminæ are generally in a horizontal position. The lower strata, often in a decomposing state, contain vegetable impressions. This rock usually rests on dark and very fissile argillaceous schist, that contains much sulphuret of iron, and forms the roof and floor of numerous beds of bituminous coal, adjacent to these streams. These beds are from a few inches to five feet in thickness, and occur at various altitudes, from 200 feet above the river to a great depth below. The salt works on the Conemaugh and Kiskaminitas, situated four miles apart, are supplied with water by boring. The richest water is procured by penetrating from four to five hundred feet. Copper tubes, 1½ inches in diameter, are inserted in the perforation, in which the salt water rises to a level with the river, accompanied by sulphuretted hydrogen gas, often in considerable quantity. This gas diminished after many outlets had been made, and the water did not rise so high. In boring, fresh water is seldom found below one hundred feet from the surface. Veins of coal and slate were penetrated at various depths, and narrow beds of limestone, lying deep, were passed through. Some of the lower strata were represented as very hard, and others soft; this last is supposed to be gypsum. Salt springs are generally struck by boring, in the ravine at Kiskaminitas; but in two instances the ground was penetrated 450 and 650 feet, without meeting salt water.

In the process of manufacturing, salt water is pumped, by horse power, into large troughs, where the earthy particles, not held in solution, mostly subside. It is then passed into the boiling pan, which is of cast iron, and shallow. After boiling a considerable time, it is drawn off into vats, where the oxide of iron, which is abundant, and earthy salts, subside, together with a portion of muriate of soda. The clear brine is passed off to a boiler, in which the salt, in fine crystals, is precipitated, and then removed to drain. No use is made of the sulphate of soda, of which there is a considerable quantity in the water. It would, perhaps, be an improvement of the process, if the precipitation of the iron and earthy salts was effected with less boiling, and the salt crystallized in shallow pans, by a heat short of ebullition; the crystals would be larger, and the salt better, and less of it lost. Fine salt, made here, does not answer for the curing of provisions for exportation.

The salt manufactured at Kiskaminitas and Conemaugh has some years amounted to 300,000 bushels; it is sold from twenty to twenty-five cents at the works. The expense of manufacturing does not exceed ten cents the bushel. A large portion of the numerous salt works are established near the river, in the ravines of the Kiskaminitas, and coal for fuel is procured from veins situated above the works, in the side of the hill, and costs but a cent a bushel.

Less salt is now made on the Conemaugh than in former years, as the springs are weak, and the price of the article too low to render it profitable. Seven years since, there was not a building in the ravine of the Kiskaminitas: it now contains a considerable population, and presents, at the base of a precipitous eminence, many dwellings and salt works, from which black bituminous smoke rises in clouds over the hills, or draws through the dusky valley. A clear stream, of considerable breadth, is seen rapidly winding among the mountains.

The western canal of Pennsylvania is carried through the valley of the Conemaugh, and will add much to the productiveness of these works, and afford great facilities for the conveyance of salt to the Atlantic and Western market. At present, it is transported on waggons to the east, and in boats, by a precarious navigation, down the Conemaugh and Alleghany rivers, to Pittsburgh.

Much salt is made near Pittsburgh, from a fountain procured by boring 270 feet. The water is strong, and is raised by a small steam engine. There is little sulphate or carbonate of lime in the water. The salt is white, and of a good quality. This fountain is sufficient for the annual manufacture of 25,000 bushels of salt. Salt is manufactured in Pennsylvania at weaker saline waters in the vicinity of the Ohio.

There are salt springs on the Chenango, in Mercer county. Near the Mahony, in Beaver county, a fountain of salt water was procured by boring to the depth of 200 feet. It is probable that strong saline water, in much of the western secondary country, may be obtained by boring, as it often occurs contiguous to bituminous coal, and is indicated by salt licks, and by slate containing sulphur.

A canal route has been surveyed through the most fertile part of the counties of Pennsylvania bordering on Ohio, to connect the waters of the river Ohio with Lake Erie, which will give additional value to the products of agriculture, and of the salt springs of that part of the state. In the summer of 1825 the price of wheat at Pittsburgh was but twenty-five cents the bushel; at the same time, adjacent to Lake Erie, from whence there was an uninterrupted navigation to the Atlantic market, it commanded seventy-five cents the bushel.

The soil, in a considerable proportion of the counties of Pennsylvainia, bordering on the state of Ohio, is fertile. The northern division of the counties contiguous to Lake Erie and the state of New York, has a good soil for grazing, and is in general heavily timbered with beech, hard maple, and birch. But adjacent to, and between the head waters of the rivers Alleghany and Susquehanna, embracing a portion of eight counties, there is an elevated, mountainous, rocky, and extensive district of country, clothed mostly with hemlock, pitch-pine, and maple, with frequent entangled thickets of laurel, almost exclusively tenanted by numerous panthers, wolves, and other wild animals found in the unsettled parts of the state, with the addition of elk and beaver.

The soil and aspect of this region is so forbidding, that it will long remain unoccupied, and much of it be ever useless for agriculture. Its mineral resources are little known, but it is reported to contain much coal, bog, and other ores of iron. In the county of Clearfield, a considerable part of which is in this mountain district, a large amount of iron is manufactured by the aid of bituminous coal and charcoal. Iron ore occurs in various parts of Pennsylvania, but is most abundant, and of the best quality, in the extensive calcareous valleys situated between ridges of the Apalachian mountains, particularly in the counties of Center and Huntington. It is mostly raised from beds of argillaceous earth, resting on limestone. The best ores of iron in this country exist in or adjacent to calcareous districts. The iron manufactured in Center and Huntington is called the Junietta, and is distinguished for tenacity, malleability, and other valuable qualities. The furnaces and forges, situated on never failing streams, are numerous. Bituminous coal, from the Alleghany mountain, is often used for making pig iron, &c. for which anthracite will probably be substituted, when the canal through the valley of Junietta is completed. About fifty per cent. of iron in pigs is extracted from Junietta ore, and it loses one-third in passing from the bloom to bar iron.

At Belfonte, a pleasant village in Center county, in the process of making bar iron, powerful rollers are substituted for the trip-hammer. The half bloom, heated by bituminous coal, is quickly passed between successive rollers, until highly compressed. A smooth bar, of the usual weight and shape, is thus produced in a minute's time. I was informed by an experienced and disinterested manufacturer, that bar iron, formed by this process, is softer than the produce of the trip-hammer, and not as desirable for plough-shares, and work subject to much friction, but for all other purposes equally good. Soft bar iron cannot be made from ores situated west of the Alleghany mountain.

There is more land capable of cultivation in Center and Huntington counties, than is common in the mountain districts of Pennsylvania. The calcareous valleys are wide and extensive, and the ranges narrow, and of little elevation. In Huntington county, a quarter of the surface is first rate land, and more than two-thirds is under partial improvement. In Center county there is a large body of table land, called the barrens, from which the timber has been cut for the use of furnaces. It is uncultivated, and held in little estimation, from its total want of springs, and the impossibility of procuring water by sinking wells. The soil is of an excellent texture for wheat or grazing, and stone rarely occurs on the surface; but the earth rests on calcareous rocks, replete with fissures, into which the rain-water sinks to a great depth. This uninhabited tract has in some places a width of five miles, and extends thirty; it would afford good ranges for sheep, if cleared of underwood.

Springs are numerous and large in these calcareous valleys. A clear, cold, and never failing mill-stream, issues from limestone caves, near Belfonte, from which the name of the village is derived.

XXXVI.—*Description of an improved Face-Chuck for Turners. Invented by Messrs.* MASON *and* TYLER, *Engineers, Philadelphia*[*].

The flat, or face chuck, is a well known and useful appendage to the lathe; but having frequent occasion to chuck a piece with its faced side outward, and finding all the usual methods too tedious and uncertain, we have contrived the chuck here described, which obviates every difficulty.

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[*] From the *Franlin Journal.*

This chuck consists of a circular plate, like that of the common face chuck; it is perfectly flat on both sides, and of equal thickness throughout, and is so formed, that when attached to the mandrel, a space of two or three inches is left between the back of it and the mandrel, so as to allow the piece of work to be fixed on either side of the plate, with its faced side either to or from the workman, as occasion may require.

The plate should be no thicker than is necessary for stability; it has a hole through the centre, and through this hole the work is performed, when the piece has been properly secured by wedging, or otherwise.

Another method, and one which we prefer, is, to add to the common face chuck, at the distance of two or three inches from, and parallel to it, a second plate, faced on the inside, and having an opening in the centre, through which the work is performed.

This second plate is supported from the first by pillars, or blocks of equal thickness, three or four being used, according to the size and shape of the piece to be chucked. Screw bolts pass through these several pillars or blocks, to secure the front plate in its place.

This chuck, with its pillars, or blocks, resembles the two plates of a circular time piece, with their pillars. In this chuck, any piece which is not thicker than the space between the two plates may be fixed for drilling or turning, with the most perfect facility; the usual way of doing this, is by wooden wedges driven between the work and the back plate. Set screws are also used, when required by the nature of the work.

XXXVII.—*A Description of the American Marine Railway, as constructed at New York, by Mr.* John Thomas, *Civil Engineer; with Explanations of its Principle, and Manifestations of its Safety for Ships of War. By* John L. Sullivan, *Esq. Civil Engineer.*

(Continued from p. 99.)

WITH A PLATE.

The lifting planes are composed of six pieces of timber, but, for the navy, may be best made of cast-iron, or of wood faced with iron. To make them, let us suppose a block, four feet long and sixteen inches square, halved horizontally, and each face of the cut marked lengthwise, and then shaped into similar planes, inclined in opposite directions; the two planes are then divided from each other by a bar of iron let in edgewise, till its edge is flush with the upper ends of the two planes, in order to guide the wedges. Now let the upper half be placed in its original relation to the under one (over it), and there will be space for two wedges, pointing in opposite directions, parallel to each other, but separated by the bar of iron before mentioned. The planes being eight, all of the same angle of inclination, the upper block, with whatever may be upon it, will be lifted *perpendicularly*, by driving the wedges. These require heavy blows, and for this purpose battering rams, each swung between two files of men, are necessary.

In practice, one of these machines, placed near a pile-block, is easily made to take the pressure from it, by the least degree of lifting; and thus several machines may be applied, so as even to take away all the common blocks, and they themselves may be readily withdrawn and shifted in position, so as to allow the bottom of the keel to be got at for coppering, shoeing, or renewing; and when done, the common blocks are replaced. To do this, *when a ship is hove down,* her keel must be completely hove out of water.

The chain, and compound windlass, by which the ship is hauled out, is an expensive and essential part of the machine. The experiments made in England, of late years, enable me to illustrate the subject of the *resistance* to be overcome on *this* railway.

The mean result may, it seems, be stated as giving, for the requisite power, a horizontal force of the 1-200th of the load, on a *smooth, hard, level,* railway.

This resistance is compounded of the attrition of the rubbing surface of the axle, and the obstacle existing at the rail, to the rolling of the wheel. But however true theoretically, that the friction must be diminished by large wheels and small axles; yet, in the treatises of both Tredgold and Wood, it is admitted to be so inconsiderable, that the principle is established in practice, that *the friction is as the weight;* and that on a smooth, hard rail, the *rolling* motion meets with no calculable obstacle. Friction is proved to be a uniformly retarding force. Velocity does not increase it: weight alone augments it, and very nearly in its own proportion.

The power to draw up a ship of 500 *tons,* weighing, as we have assumed, one half the same number of tons, is now to be considered. As the experiments in England ranged from the 1-60th to the 1-300th, I shall, instead of 1-200th, say 1-100th of her weight is the ratio. To this we have to add the resistance from gravitation in ascending the plane.

The gravitating force of the plane will be to that of the whole gravitating force of the body, falling freely, as the perpendicular height of the plane is to its length.

The elevation being 1-20th, or 25 in 500 feet; if the ship weighs 250 tons, and the carriage 50 tons ($300 \times 25 \div 500$), the gravitating force down the plane is 15 tons. To which must be added the 2½ tons for the 1-100th of the ship's weight, and half a ton for the carriage weight, on a level, which 18 tons is 40,320lbs. which the chain must bear: and we have stated, that a bar of one inch square, of pure iron, will bear 74,800lbs.

The chain of a marine railway must be, however, exposed to accidental stress beyond this calculation. It has to ply around a *rotch*-wheel, and animal force is often irregular. A steam engine, whose power can be steadily augmented and controlled, would be the best, when its surplus power can be employed to other labour-saving objects, as for instance the smithery of the establishment.

The shape of the chain, in order to give it a degree of strength proportionate to the material, is important, as it has to bear the stress in turning around the *rotch*-wheel, of the windlass.

The windlass is so geared as to adopt it to the power of a few horses: when they travel in a walk, the ship moves up the plane about three feet in a minute, and she is completely up in less than two hours. Four horses are a sufficient force for a ship of 500 tons. The horses work in the second story of a small building; they are attached to bars 14 feet in length, proceeding from an upright shaft, on the lower part of which is a bevel wheel, communicating with the rest of the gear.

The end of the chain is strongly fastened to the centre of the carriage, with branches passing obliquely to its sides, so that the whole must move equally, and at once.

The reversal of the draught, at will, is an essential provision, in order to draw the carriage out to the extremity of the ways, to which its own gravity would not *certainly* carry it; because, to be able to give the carriage such a position as to afford just enough for the ship to ground on the upper blocks is indispensable. To be able to re-float the ship, should she happen, by bad management, to ground, otherwise than on the centre of the carriage, may, if on a falling tide, be of great consequence; we must therefore have the readiest means of drawing the carriage down the ways. With this view, the chain, after passing the *haul up wheel,* is led to another *rotch* with reversed teeth, and thence down along in a trunk, by the centre timber of the ways, till near their extremity; there it turns around a large and strong shiver, and fastens about twenty feet from the end of the carriage, which the chain follows when drawn up, it being supported on rollers. The reversed movement, of course, draws the carriage down, till it touches the stop timber at the outer end of the railway. The chain is thus disposed of without manual labour. The connection of the second rotch with the first is by intervening gear, so that they move alike.

The ship in descending requires a controlling power, that she may not acquire momentum, and injure the carriage by velocity. The friction for this purpose is produced by means of an iron wheel on the upright shaft, placed just below the floor; an iron band is made to clasp this wheel, by the aid of a powerful lever; this is found to be quite sufficient, and very convenient.

The manner of receiving a ship is this :—she is brought between the wharfs of the dock, head on; the carriage is drawn down under her, and perhaps up a little, till her *fore-foot* grounds on the forward block; and as ships generally draw more water aft than forward, she is *nearly* aground aft also. The head shores are applied, she is then moved up a few feet, until she is ascertained to touch aft also. The shores are now all applied, and secured, and the bilge levers are hove up to their bearing. She is now ready to rise into the light and air.

I here ask leave to anticipate a mechanical objection to the size of our wheels. *They are small,* because it is an object to keep the carriage *low,* that we may not have to extend the ways farther than is necessary to get the desired depth of water on the carriage. I am fully aware that it may be said, that *rollers* would be attended with less friction than wheels. True, but we could not employ them in a sub-marine movement. They cannot have fixed stations, because they cannot have axles ; and if not kept at right angles to the way, they would incline aside. Above water they might be attended to. We must, however, at present content ourselves with our small wheels, according to the local situation, and the size of the ship to be received, waiting until greater ingenuity shall devise a better plan. There will be no difficulty in hauling up any ship on a smooth, hard, and true rail. I only insist that it would be *false economy to slight* any part of this kind of structure, which is, of course, only accessible, for repairs, by the diving bell; unless, indeed, a frame is to be taken up, for which provision is made while putting them down. In all places exposed to the worms, the timber must be *coppered,* unless the *white gum tree* is found unassailable, as some have represented.

Of the expense, it is sufficient to remark, that every principle being within the rules of mechanical computation, it will not be difficult to make an estimate, when the ground is known and the prices of materials settled. It will then depend on the size, and other circumstances of the work to be performed.

It may thus have been made to appear to the institute, that the American marine railway is as well adapted to the ports of the United States, as that of Scotland is to the northern ports of Britain. And from the united testimony of experience, and of science, that it is on many accounts, besides that of saving expense, *preferable to the dry dock.* It will give to steam batteries, contemplated in the late report of the secretary of the navy as a branch of harbour and sea coast defence likely to be increased, a facility of careenage and repairs almost denied to them in any other method.

While, as an individual, I would not be understood to express the opinion, that the dry dock may not be necessary for our ships of the line; yet I think that it has been made to appear from this statement, that the marine railway is convenient, expeditious, and economical, for the smaller class of ships of war. It is peculiarly adapted to alluvial soils, such as the shores of most of our southern harbours. It is, at least, far more economical for our mercantile marine, than the old custom of heaving down; and I am happy that complete success, in the first example of this machine in full practice, enables me to submit it with confidence to your examination.

I am, gentlemen, respectfully, your humble servant,

JOHN L. SULLIVAN.

An approximation to an estimate of the cost of a railway dock, at Philadelphia, for ships of 500 tons and under.

The implements (expedient to be preserved), viz. the diving-bell, pile-driver, and their scow, cost, at New York . . . . . *Dollars.*	3,300
Various tools	700
The foundation piles; the number and length of them will depend on the nature of the ground, assuming that the number will be 300, and the materials and fixing at three dollars each, is	900
Frames to bear the iron rails, and connect all together, 7,600, at 30 cents each	2,280
The capstan house, two stories high	600
Iron work, consisting of the rails, rack, saddle pieces, axles, wheels, gear of the windlass, shafts, plummer, boxes, levers, bolts, and fastenings of every kind, according to experience in New York	12,500
The chain is of a peculiar construction; 300 feet will weigh 20,400lbs. at 20 cents	4,000
Labour, driving the piles, and carpenters' work, estimated at .	3,500
Land, and wharfs, will probably cost about	10,000
Supervision	1,000
Dollars	38,780

If the same establishment should have a second railway, of dimensions suitable for ships of 200 tons and under, it may be built for the additional sum of 17,000 dollars.

The income from the principal dock, besides the wharfage, may be estimated as follows, the rates of toll being placed at 25 cents a ton, as established in New York. If then one hundred vessels, averaging 200 tons, be drawn up in a year, it will amount to 5000 dollars. The expense of management must be deducted; but a reasonable income from the investment will still remain. The dock would, however, be capable of doing more business, should the demand for its use be greater.

References to plate VI.

Fig. 1, a ship on the railway.—*a*, windlass loft; *b*, windlass; *c*, chain; *d*, shear shores applied.

Fig. 2, a stern view of a ship on the railway.—*a a a*, the railway; *b b*, carriage wheels; *c c c*, carriage cills; *d d*, cross ties; *e e*, bilge levers; *f f*, shear shores; *g g*, scaffold posts.

Fig. 3, a perspective combination of the shear shores and bilge levers.—*a*, the ways; *b*, the iron rail; *c c c*, the wheels; *d*, the cill; *e*, the plank; *f* the cross tie; *g g*, the hollow quoin blocks; *h*, the shear shore; *i*, the screw; *k*, the windlass; *l l*, the bilge levers; *m*, the prop.

(*To be continued.*)

XXXVIII.—*On a simple means of separating the Yellow Colouring Principle from Madder, and rendering it proper to afford the Red, Lilae, Violet, and Brown Colours used in Dying and Printing Wool, Silk, Cotton, and Linen. By* Mr. G. H. DE KURRER[*].

THE author states, that the treatise published by M. M. Kahlmann, Colin, and Robiquet, have determined him likewise to communicate a simple means of separating the red colouring principle of madder. He had repeated most of the old practices, and especially that of M. Mérime. The object of these processes was, to wash the madder in order to separate the yellow colouring principle, but which also carried with it three-fifths of the red colouring matter. With a view to avoid this loss, M. Kurrer submitted the madder to maceration in pure water, and to the alcoholic and acid fermentations. He lastly washed it, until he found that the water from the washings no longer changed the colour of litmus. The madder which he obtained by this means had every desirable quality; but he found it so difficult to stop the acid fermentation, as to render the process not practicable on a large scale, and especially because this fermentation also liberated a considerable part of the red matter.

The author finally submitted the madder to the alcoholic fermentation only, and immediately washed it. This process completely succeeded, and he applied it to all the varieties of madder, without meeting with any difficulty. The following is the description of the process:—

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[*] From the *Polytech. Journal*, von Dingler, Jan. 1827; *Ferussac's Bulletin des Sciences Technologiques*, June, 1827.

He employed three tubs, A, B, and C, which he placed near to each other, and in summer in the open air, under a hovel or open shed; but in winter he removed them to a cellar, the air of which he maintained at a temperature of about 18° or 20° of Reaumur*. The vessel A served to effect the fermentation in, and contained from 50 to 55 pounds of madder; it was two feet eight inches deep, and two feet six inches in diameter. The tub B, or washing vessel, was five feet and a half in height, and three feet in diameter; this was furnished with three wooden cocks, the first placed at two feet, the second at three feet, and the third at four feet above its bottom. The vessel C served as a deposit: its height was four and a half feet, and it had a cock placed at the height of a foot and a half above its bottom. In commencing the process, he placed in the vessel A from 50 to 55 pounds of ground madder; he then added water, stirring the mixture continually, until the madder, when at rest, was covered with an inch and a half of water. He then left it at rest until the fermentation took place, and raised a crust of madder up to the surface, and which usually happened at the end of thirty-six hours, or more tardily in forty-eight hours, according to the temperature of the air. This is the favourable time for transferring the mass into the vessel B; and when this is done, that vessel is filled up with water; it is then suffered to remain at rest for two hours, during which time the madder precipitates. The first or uppermost cock is then opened, next the second, and lastly the third, and the liquor collected from the second and third cocks is carried to the tub C, in which it completes the precipitation of that madder which had escaped from the vessel B. They then continue to make two, three, or four repeated washings of the madder in the vessel B, until the washing water becomes no more coloured. The madder, thus purified, serves for dyeing, and in the manufacture of woven goods by all the known processes; but it is important that in summer the utmost care should be taken to prevent the madder from undergoing a second fermentation. The madder in the vessel C, after being washed and precipitated, is just as good as the other. We might, perhaps, employ the first liquor, separated from the fermented madders, with advantage, in the preparation of the heated vessels used in making indigo, or woad, as well as in the improvement of the madder.

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* Or from sixty six to seventy degrees of Fahrenheit's thermometer.

D. B. F.

Remarks by the EDITOR.

The Editor was some time since favoured by Dr. Dingler with some exquisitely beautiful specimens of calico-printing, produced in a manufactory in which he is concerned, and chiefly by the *discharging process*, now coming into such universal employment amongst us. The reds, pinks, and purples, were exceedingly pure and brilliant, and might possibly have been produced by treating the madder upon a plan similar to the above. At any rate, coming from such a quarter, and from so intelligent a judge as Dr. Dingler is, this communication is entitled to the highest consideration amongst our dyers and calico-printers. The beautiful *self-green* produced from the chromic acid was first noticed amongst these specimens by the Editor.

XXXIX.—*Additional particulars of Mr. Perkins's High Pressure Steam Engine.* *By* JOHN MARCH, Esq.

SIR, *Greenwich, July* 12, 1827.

HAVING very recently witnessed at St. Catherine's Dock, London, the extraordinary power of Mr. Jacob Perkins's high-presure, single-stroke, safety engine, I have the pleasure of stating a few important facts, reserving for myself a future representation of its additional advantages, my present observations having principally in view to explain some points which seem to have been much misunderstood, or, if observed, not to have been sufficiently appreciated. Indeed it appears that the observations which the inventor has confidently made, long before the engine was first proved, have been nearly treated as mere assumptions. Any information, therefore, given to the public on so interesting a subjects will, it is presumed, prove acceptable.

The most important fact to be considered is the *perfect safety* of Mr. Perkins's *steam generators,* which may now with truth be declared to have wholly superseded the necessity of using boilers of any description, to which, however well made, must be attributed the fatal accidents constantly recorded.

From calculations made with very proximate accuracy, it evidently appeared to me, that the quantity of water injected per minute was 266 cubic inches, being less than one gallon by 16-288ths, or 1-18th.

It becomes necessary to state, that the work to which Mr. Perkins's single engine was applied, was to pump water out of the dock now constructing; to perform which two double engines, on the principle of Bolton and Watt, are used; one of sixteen, the other of ten horses' power. As the two engines required some repairs, they were stopped, and that of Mr. Perkins was applied to perform the same work, which it has most succesfully effected, by keeping the water clear; thus doing alone a work equal to that of the two engines; that is to say, the work of 26 horses' power. Mr. Perkins's engine, in performing this, worked with a pressure of 35 atmospheres (equal, according to some, to 525lbs.; but, according to Doctor Wollaston's more correct mean, equal to 490lbs. to the square inch), with a consumption, per hour, of only one bushel of a mixture of coke and coal; and the constant rate of the engine was sixty twenty-inch strokes per minute. The coke used far exceeded the proportion of Newcastle coal. Now, on a reference to Mr. Watt's calculation, the quantity of coal used for a 26-horse power steam-engine per hour, is three bushels;

and as we may fairly conclude that this single engine of Mr. Perkins's performed the duty of two engines, together equal to 26 horses; so the reduction of two-thirds of the fuel may, by a parity of reasoning, prove to be a point of the highest importance and which is still further increased through the use of coke. Indeed, from the peculiar construction of Mr. Perkins's generators, coke seems much better adapted than coal, which expends itself too readily, and before the caloric can have its full action. The smoke which is observed to issue from the chimney of most steam-engines, at every fresh supply of coals, is another evil, which will be obviated by the manner in which Mr. Perkins's generators are fixed, they acting in a great measure as smoke consumers.

I most attentively made my observations during the trial of this engine; and some share of experience enables to say, that for an experiment (for it is only an experimental engine), it may be fairly pronounced to be as conclusive and satisfactory as any that has ever been made.

I am, sir, your most obedient servant,

To T. GILL, *Esq.* JOHN MARCH.

XL.—*On the mischiefs arising from the employment of Fir, Pine, and Cedar, in packing Astronomical and Surveying Instruments, Time-pieces, &c. By the* EDITOR.

MANY years ago, the Editor was shown a surveying instrument by its maker, Mr. E. Troughton, F. R. S. which had been sent to a hot climate, and was returned to him that it might be put into order, as it was covered all over with a *viscid coat of varnish,* which had entirely prevented the motion of the sliding parts of it; and, in short, it would require to be taken to pieces, to have its coat of securing varnish removed, and to be again fresh varnished, to fit it for use.

These evils were occasioned by the employment of slips of *cedar* in the packing, as it is termed, of the instrument in its mahogany box; and would prove, as he said, a salutary lesson to him, against ever employing so mischievous an article in future.

This fact has been lately recalled to the Editor's notice, by another and a somewhat similar circumstance. Mr. J. Lukins being about to return to the United States, and having had a marine chronometer made, required a packing case to enclose the mahogany box containing it; he, however, stated that he should carefully avoid the use of one made of *pine*, as a *volatile varnish* was disengaged from it, which would *thicken the oil* applied to the movements of the chronometer!

Of course, equal care should also be taken to reject the *shavings of fir, pine, cedar*, and other similar woods, which are ordinarily employed in filling up vacancies within and around packages, or the same evil results will certainly be experienced; and it shows from what seemingly trifling causes, the very worst effects, in respect to the performance of these and other delicate instruments, may be often produced.

LXI.—*On the different Black Colours. By the late celebrated* WILLIAM LEWIS, *M. B. and F. R. S.*

(*Continued from p.* 112.)

SECTION V.

Black Paints, Varnishes, &c.

Black Paint with Oil.—Black oil paint is prepared, by grinding, with a proper quantity of oil, the charcoal or soot blacks, or the natural black earths, or pit-coal, till they are united into a smooth, uniform, thick compound, which is occasionally diluted with more oil, to a due consistence for being worked freely with the brush or pencil.

The finest black colour is made with ivory-black ground, before the addition of the oil, into an impalpable powder. The material most commonly made use of is lamp-black, whose colour is, for most purposes, of sufficient deepness and beauty. The unctuosity of lamp-black gives it an advantage above the other pigments, of mixing more easily and perfectly with the oil; but, from the same quality, it receives a disadvantage of being too slow in drying, for the dispatch requisite in business. Some deprive it of this imperfection by burning it, that is, by heating it red hot in a close vessel; but being by this means reduced to the state of coal, it is deprived also of its easy miscibility with oil. It may, however, be made to dry as speedily as other oil paints generally do, by a due preparation of the oil; as particularly by setting it on fire and boiling it, in the manner hereafter described for making printers' ink.

The oil for all paints requires some preparation to promote its own drying, and the method here recommended, appears, for this purpose, both the most expeditious and the most effectual. The dark colour which it commonly acquires in the process, and which renders it unfit for the brighter coloured paints, is of no inconvenience to it for blacks. The oil is made considerably thick by the boiling, and being in this state well mixed with the black matter, the mixture is diluted for use, with unboiled oil, to which it communicates a sufficient degree of the drying quality desired.

Black Paint with Water.—An opaque deep black for water colours is made by grinding ivory-black with gum water, or with the liquid which settles from whites of eggs, after they have been beaten up and suffered to stand a little. Some use gum water and the whites of eggs together; and report, that a small addition of the latter makes the mixture flow more freely from the pencil, and improves its glossiness.

It may be observed, that though ivory-black makes the deepest colour in water, as well as in oil painting, yet it is not always on this account to be preferred in either kind to the other black pigments. A deep jet black colour is seldom wanted in painting, and in the lighter shades, whether obtained by diluting the black with white bodies, or by applying it thin on a white ground, the particular beauty of ivory-black is in a great measure lost: the same intentions may be answered by pigments of less price and more easily procurable.

A valuable black for water colours is brought from China and the East Indies, sometimes in large rolls, more commonly in small quadrangular cakes, generally marked with Chinese characters. By dipping the end of one of these cakes in a little water, and rubbing it about on the bottom or sides of the vessel, a part of its substance is taken up by the water, which may thus be readily tinged to any shade of black or grey, from such as will just colour paper to a full black. The composition of this Indian ink has not hitherto, so far as I can learn, been revealed, and I therefore made some experiments with a view to discover it.

Though the Indian ink is readily diffused through water, it is not truly dissolved: when the liquid is suffered to stand for some time, the black matter settles to the bottom in a muddy form, leaving the water on the top colourless, in the same manner as the common black pigments settle from diluted gum water. The ink kept moist in warm weather becomes in a few days putrid, like the fluid or soft parts of animals; as does likewise the clear water after the black matter has settled, and been separated from it. The Indian ink appears therefore to contain an animal substance soluble in water, and to consist of a black powder mixed with some animal glue. For the greater certainty in regard to the conglutinating ingredient, I boiled one of the China cakes in several fresh portions of water, that all its soluble parts might be extracted, and having filtered the liquors through paper, set them to evaporate in a stone bason: they smelled like glue, and left a very considerable quantity of a tenacious substance, which could not be perceived to differ in any respect from common glue.

Being thus convinced of the composition of the mass, I tried to imitate it, by mixing some of the lamp-black, which I had myself prepared from oil, with as much melted glue as gave it sufficient tenacity for being formed into cakes. The cakes, when dry, answered fully as well as the genuine Indian ink, in regard both to the colour, and the freedom and smoothness of working. Ivory-black, and other charcoal blacks, levigated to a great degree of fineness, which requires no small pains, had the same effect with the lamp-black; but in the state in which ivory-black is commonly sold, it proved much too gritty, and separated too hastily from the water.

Composition for marking Sheep.—Great quantities of wool are annually made unserviceable by the pitch and tar with which sheep are marked, and which are commonly laid on with on sparing hand, as they considerably increase the weight of the fleece at a trifling expence. With a view to prevent, as much as possible, this great waste of so useful a commodity, the society instituted in London for the encouragement of arts, manufactures, and commerce, and who continue vigorously and judiciously to prosecute the important ends of their institution, offered a considerable premium for the discovery of any cheap composition that might supply the place of those hurtful materials, whose colour should be long and lasting, which should bear the weather a proper time, and not damage the wool. Several proposals for this purpose were laid before the society, but none of them have as yet been thought deserving of the premium. The enquiry having been warmly recommended to me by the late Dr. Hales, as an object of very great importance to the woollen manufactory, I went through a set of experiments with this view in the year 1759.

It was hoped that the ill qualities of tar and pitch might be corrected, by mixing with them some soap or size, which should prevent their too great adhesiveness, and render them so far dissoluble in water as to be dischargeable from the wool by the means commonly practised for cleansing it; or, in failure of pitch and tar, that some composition of resins, oils, or fats might be found, which should be rendered harmless to the wool by the same correctors, and which should serve as sufficient cements for certain coloured powders, among which black appeared to be the best, as being the strongest and most conspicuous colour. On these principles many trials were made, but with little success; for the unctuous and resinous materials, with the advantage which they received from the soap or size, of being easily washed out from the wool, received also the disadvantage of being too soon discharged by the weather.

It was next considered, that as wool has always a natural greasiness, which the workmen wash out with stale urine, soap, or ley, as described in the sequel, the common animal fats might probably be discharged from it by the same means, so as not to stand in need of those ingredients, from which the foregoing compositions had contracted the imperfection of being too easily dischargeable. Accordingly I melted some tallow, and stirred into it so much charcoal in fine powder as made it of a full black colour, and of a thick consistence. This mixture, easily procurable, and at small expence, being applied warm, with a marking iron, on pieces of flannel, quickly fixed or hardened, bore moderate rubbing, resisted the sun and rain, and yet could be washed out freely with soap, or ley, or stale urine. All the good qualities that can be desired in a composition for marking sheep, appeared therefore to be united in this simple preparation.

Though the mixture of tallow and charcoal powder was found sufficiently durable, when applied as above, upon pieces of flannel, it occurred that it might, nevertheless, by the repeated attritions to which it is exposed on the body of the animal, be in danger of being rubbed off too soon. If we could add to the composition a little pitch or tar, we should effectually secure it against any inconveniency of this kind; and it was apprehended that these ingredients might be added with safety; for being perfectly dissolved by the tallow, it might be presumed that they would wash out along with it from the wool. Thus we see stains of tar got out from clothes by means of oil, which, dissolving the tar, the whole compound is then discharged by the same detergents that the oil itself would be. I therefore melted some tallow with an eighth, with a sixth, and with a fourth of its weight of tar, and having thickened the mixtures with charcoal powder, spread them while hot upon pieces of flannel. None of the compositions could be discharged by any rubbing or washing with water. By soap, they were all washed out completely; that which had the smallest proportion of tar, easily enough; that which had the largest proportion, difficultly. If, therefore, it should be feared that the tallow will fail in point of durability or adhesiveness, which, however, I do not apprehend it will, it is plain that as much as can be desired of this quality may be communicated, without damaging the wool, by a proper addition of the substances commonly made use of. I do not conceive that the nature of the thing can admit of any greater perfection.

There is a material circumstance in this affair, which does not seem to have been sufficiently considered by those who proposed the inquiry. If we could discover, which some have fruitlessly endeavoured to do, a staining composition in the nature of a dye, possessing all the good qualities that have been mentioned, it would scarcely be possible, as matters stand at present, to induce the farmers to make use of it. They require a substance that will add weight; and I apprehend that it will be no small recommendation to the above composition, that in this respect, as in all others, except its being innocent to the wool, it agrees as nearly as can be expected with the materials to which they have been long familiarised.

Composition for preserving wood, &c.—The great adhesiveness which renders tar unfit, as a principal ingredient, and excellent as a secondary one, for the purposes of the foregoing article, adapts it to another use, on some occasions not a little important; that is, the preservation of some kinds of wood, on the outsides of certain buildings, the covering of sheds, paling, &c.; as also for coating common tiles, in imitation of the black glazed tiles, which are sold at a much higher price.

Tar and pitch, of themselves, are too soft for these intentions, even the pitch being liable to be melted off by the heat of the sun in summer, however firm in the cold of winter. Different powdery substances, as ashes, ochres, and other mineral pigments, have been mixed with them, but without remedying the imperfection so effectually as could be wished. In the Swedish Transactions for the years 1740 and 1742, two compositions are recommended, which are said to be firm, durable, and glossy.

One is prepared by melting the tar over a moderate fire, so as to make it fluid, but not to boil, and stirring in as much coal dust as will render it thick. This mixture, the author says, is to be laid on with wooden trowels, in a hot day, as thick or as thin as shall be thought proper. The other is prepared by mixing the melted tar with a sufficient quantity of lamp-black; a little of this mixture is spread upon the upper side of each tile, with a stiff, short-haired painting brush; next day, when dry, the tiles are done over with tar alone, and two days after with tar again; this coating being well dried, which in summer, according to the author, is generally in eight or ten days, some powdered lead ore (galena) is strewed over it, and well rubbed in, first with a coarse, and afterwards with a fine linen cloth; from this it receives a sparkling appearance.

I tried both these compositions, and found them of a good black colour: when the bodies coated with them are held before the fire till the surface begins to run, they become glossy. They are not, however, wholly exempt from the inconveniencies complained of in the others; for, though the tar was made as thick, both with the coal dust and lamp-black, as was consistent with its being spead smooth, even in a hot sun, and while warm from the fire, it afterwards softened in the sun considerably, though the parts which the sun did not immediately shine upon proved sufficiently firm in the hottest weather.

By coal dust, in the first composition, is meant powdered charcoal. Suspecting, however, that pit-coal, in virtue of its bituminous nature, might unite more perfectly with the tar, and be, in some measure, dissolved by it, I made trial of this also, chusing the finest coloured pieces, of those kinds which melt in the fire, and grinding them into impalpable powder. The mixture of this powder with the melted tar, made of such consistence as to be freely spread while warm, with a brush, seemed to soften less in the sun's heat than either of the other two. The durability of these compositions I cannot yet determine; after having stood, without any apparent alteration, one summer and winter, they continued exposed to the weather, for discovering what effects longer time and vicissitudes of seasons may have upon them.

(*To be continued.*)

XLIII.—*Testimonies in favour of Mr.* I. LUKENS'S *improved mode of Hardening small Chronometer Balance Springs.*

IN our last number, page 75, we announced that Mr. Lukens had discovered an improved, scientific, and simple process, for hardening the small balance springs of chronometers *bright*, or without *discolouring* them. We have now to add, that several of our superior chronometer-makers have already judiciously availed themselves of this improvement, and some have afforded us their testimonies in its favour. We therefore trust that others will now follow their example, and that Mr. Lukens may in consequence be in some measure repaid for his discovery, and also for the very liberal terms on which he has determined to disclose his secret, and which terms may be known on application to us, as well as the particulars of his process; which, as we before stated, he had confided to us.

Mr. John R. Arnold writes to us as follows:—

SIR, *Royal Exchange, London, Aug.* 23, 1827.

I am happy to bear testimony to the excellence of Mr. Lukens's new method of hardening steel balance springs for chronometers.

The difficulty of preserving the pristine excellence of the steel will be conquered; and although the result can only be ascertained by a sufficient trial, through the various adjustments, yet I have the strongest impressions on my mind that it will be crowned with success.—I have the pleasure to subscribe myself, sir, your humble servant,

To T. GILL, *Esq.* JOHN R. ARNOLD.

Messrs. Parkinson and Frodsham's testimony follows:—

SIR, 1, *Change Alley, London, Aug.* 20, 1827.

With respect to the process of Mr. Lukens, for hardening chronometer springs, as exhibited to us, its superiority is unquestionable. Whether it may be productive of any other advantage, will require both time and observation to determine.—We are, sir, your obedient servants,

To T. GILL, *Esq.* PARKINSON AND FRODSHAM.

Mr. R. Widenham states as follows:—

SIR, 6, *East Street, Red Lion Square, London, Aug.* 25, 1827.

The best proof I can give of the efficacy of Mr. I. Lukens's method of hardening pendulum springs for chronometers, is, that I do not intend, for the future, to adopt any other. I have made several, and find them to answer completely according to my wishes.—I remain, sir, your obedient servant,

To T. GILL, *Esq.* R. WIDENHAM*.

* Mr. Widenham gained the premium of 300*l.* assigned by the Lords of the Admiralty, for the best chronometer, after one year's trial at the Royal Observatory, Greenwich, in the year 1825.—EDITOR.

And Mr. J. Green has likewise furnished us with his approbation of the method as follows:—

31, Great Ormond Street, Queen's Square, London,
SIR, *Aug.* 24, 1827.

The mode of hardening chronometer pendulum springs, communicated to me by Mr. Lukens, I consider superior to any I have seen, and another step towards the perfection of these instruments.—I am, sir, your obedient servant,

To T. GILL, *Esq.* J. GREEN.

XLII.—*On the Marine Chronometers made by Messrs.* PARKINSON *and* FRODSHAM, *of London.*

CAPTAIN SABINE, provided with the best instruments of every description, belonging to the Royal Society, to the Board of Longitude, or his own private property, and four chronometers, lent by Messrs. Parkinson and Frodsham, sailed for Sierra Leone, where he arrived on the 22d of February, 1822, when he commenced his operations (on determining the figure of the earth by means of the pendulum vibrating seconds in different latitudes). He then proceeded successively to St. Thomas's (on the coast of Africa), Ascension, Bahia, Maranham, Trinidad, Jamaica, and New York, whence he returned to London on the 5th of February, 1823. Whilst at Maranham, Capt. S. had written to Sir Humphrey Davy, proposing to extend the experiments to the high latitudes. On his arrival in London, he had the satisfaction of finding that his proposal had been approved of by the board of longitude and the Admiralty; and the Griper, which had been employed in the North-west expedition in 1819-20, was commisioned on the 26th of February by Capt. Clavering (who also commanded the vessel in which Capt. Sabine had made his late voyage); and on the 11th of May he sailed for Hammerfest, in Norway: the three stations visited were Spitzbergen, Greenland, and Drontheim, in

Norway, whence he returned to London, where he arrived on December the 19th.

Though the work from whence we have derived the above extract is scientific (for the larger portion consisting of tables), yet there are many points which are interesting in the perusal. Among these, we cannot but notice the extraordinary degree of perfection to which the various instruments are now brought; and at the same time, the astonishing care, patience, and accuracy, which are indispensable in the observer; qualities which Capt. S. evidently possesses in a high degree. In speaking of the instruments, he repeatedly mentions, with peculiar praise, the admirable chronometers of Messrs. Parkinson and Frodsham. "It would be impossible," says he, "to express the advantage of which their chronometers proved to me on all occasions, or how much the thorough reliance which I could place on their time facilitated; or, what is more important, how much it conduced to the accuracy of the variety of observations which successively occupied my attention, and which I was usually pressed to complete in the shortest possible time."

Considering the influence which change of climate is known to exercise on the going of a watch, it must appear the more extraordinary, that these chronometers should have stood so severe a test as they were exposed to, in the voyages described. But there is one point which we consider of so much importance, and in which Capt. Sabine's opinion is so decisive, that we think it necessary to notice it particularly. He says:—

"It is known that the rates of chronometers are frequently found to vary on embarkation in vessels, inasmuch as to have given rise to the distinctive terms of 'sea rates,' and 'land rates.' No such variation, however, can be found in the going of No. 423, in any one of the six voyages in which it was embarked between April and November, which alternated with nearly equal periods on land when it was employed incessantly in observations, including those of magnetism."

In a note to this passage, Capt. Sabine says :—

"An opinion has lately prevailed, that the change in the rate of chronometers on embarkation, which used to be considered as a consequence of the motion of a ship, is principally occasioned by the magnetic influence of the iron which she contains; and it has been assumed by some of the writers who have taken part in the recent discussions on the subject, that the effect so attributed is one of general experience. I believe, on the authority of others, rather than from my own observations, that a difference has sometimes and even frequently taken place between the land and sea rates of chronometers; but from whatever cause the irregularity may arise, I must regard its occurrence as an evidence of the inferiority of the peculiar chronometer to the advanced state to which the art of their construction has attained; because, among the many with which I have at different times been furnished by Messrs. Parkinson and Frodsham, and which I have frequently transferred from the ship to the shore for two or three weeks at a time, for the purpose of trial, I have never been able to discover any systematic variations whatever, consequent on their removal. With regard to the influence of the iron as a cause of the irregularity, a more decisive evidence of its not being practically discovered under the most favourable circumstances for its exhibition can scarcely be imagined, than took place in the four chronometers of Messrs. Parkinson and Frodsham, of which I have given an account in the appendix to Captain Parry's voyages in 1819-20, pages vii. to xii. xviii. xix. and xx. as follows:—

"The Hecla was stationary and immoveable, being frozen up for more than ten months in the vicinity of the magnetic pole; the dip between eighty-eight and ninety degrees. Such is the situation, and such the circumstances which are supposed to be the best adapted for the developement of magnetism in the stancheons and other irons of a ship. The chronometers were on board during the whole winter, and their rates, preparatory to the following summer, were assigned from the average of the four months immediately preceding her extrication from the ice, at an equal period of navigation. The Hecla arrived at Leith, having experienced much bad weather in crossing the Atlantic; but, on comparing the four chronometers at the observatory at Leith, their Greenwich time, employing their winter harbour rates, proved less than two seconds in error. On the arrival of the Hecla in the Thames, the chronometers were returned to Messrs. Parkinson and Frodsham's house in London, where, after a month's interval, they were found still going at the same rates as in the Hecla, whilst in the harbour of Melville Island."

Having succinctly mentioned the results, Captain Sabine adds—"These particulars are stated in detail in the pages referred to, but the circumstance is thus again generally noticed, because it seems to have been overlooked by many whose ingenuity has been exerted in devising contrivances to remedy an evil which has no existence, when the common discretion of life is exercised in obtaining the better article at an equal price. Had the especial purpose of the Hecla's voyage been to enquire whether the iron of a ship, in its ordinary distribution, would, under such extreme circumstances, exert a sensible influence on the chronometers, better adapted arrangements could scarcely have been devised for the experiment, nor could a more decisive result in the negative have been obtained."

The Russian corvette Krotky, commanded by Baron Wrangel, just returned from a voyage round the world, upon which she has been employed about two years, has arrived at the Motherbank. This voyage has afforded another practical and additional proof of the extraordinary accuracy and perfection to which Messrs. Parkinson and Frodsham have brought their chronometers, two of which were bought by the imperial government for this voyage; one of which, when delivered, was losing in mean time half a second per day, and at present is losing one second and three-tenths, and during the whole time of circumnavigating the globe never exceeded two seconds losing. The other's original rate was one second and a half gaining, and its regular and progressive increase has never exceeded three seconds and eight-tenths, balancing each other's errors (if errors they can be called) in the most surprising manner. Baron Wrangel adds, in a letter to Messrs. Parkinson and Frodsham, that his vessel was by no means calculated to give chronometers a favourable trial, it being small, and subject to considerable motion. These chronometers have been out two years, and in the greatest extremes of temperature. The following is a copy of this letter :—

"*Portsmouth, August* 14, 1827.

"GENTLEMEN—It is with great satisfaction that I am enabled to inform you, that the two chronometers, Nos. 645 and 646, which have accompanied me on the voyage round the world in the years 1825-6, and 7, have turned out to be so correct, that the first differed only from one half to one and three-tenths losing, and the latter from gaining one half to four and six-tenths seconds; and that the differences of longitude, which were found by their means, corresponded exactly with the best astronomical observations. I am convinced, that however near to perfection your chronometers have proved to be, that they, no doubt, would have been more so had I been enabled to pay greater attention to them, and my vessel been fitted up as I could have wished it to have been for that purpose.

"I am, gentlemen, your very humble servant,
"BARON WRANGEL."
Capt. of his Imperial Majesty's
Corvette Krotky.

To Messrs. PARKINSON *and* FRODSHAM, *Chronometer*
Makers, 'Change-alley, London.

XLIV.—*On lessening the Expence, and increasing the Salubrity, of the Processes of refining Gold and Silver in France**.

THE frequent complaints made against the laboratories for refining gold and silver to the administration, and finally to the Council of Health, in Paris, have urged the latter to study the means of lessening the unhealthiness of this art: and by which means it is now ranked in the second class of unhealthy laboratories, a class of laboratories which were, however, formerly shut up when in the centre of a town or village. The Council of Health applied these means to an establishment, which has been carried on during a whole summer upon these plans, now just published by M. d'Arcet. This publication is preceded by some general observations on the state of perfection to which the art of refining is now brought in France.

In refining, it is proposed to separate gold and silver from their alloys. Formerly gold was refined by a prolonged fusion, by cementation, by means of sulphur, nitre, sulphuret of antimony, and corrosive sublimate; and silver by a tedious fusion in the open air, mixed also with sulphur and nitre. Cupellation and the liquation of silver is of modern invention; and the parting of gold dates from the fourteenth century. It was M. d'Arcet, the nephew, who first employed platina vessels in the refining of gold by sulphuric acid.

In 1789, ingots of silver, containing a small quantity of gold, were refined by fusion with nitre, treating them in earthern vessels with nitric acid; and, lastly, precipitating the silver, by means of copper. The nitrate of copper was afterwards calcined with charcoal, to revive the copper. The nitre, the nitric acid, and the fragility of the earthern vessels, however, rendered this a very expensive process.

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* From Ferussac's *Bulletin des Sciences Technologiques* for June, 1827.

In the treatment of these ingots by the new method, they first melt and granulate the ingots, which are then dissolved in sulphuric acid, contained in vessels or boilers of platina. The gold, thus separated, is subjected to a second process, it being fused with nitre and borax. The sulphate of silver is precipitated by copper, and the sulphate of copper thus obtained, after being evaporated and crystallized, is sold in commerce. This process, besides the striking advantages which it possesses over the ancient ones, in respect to economy, enjoys also the advantage of merely giving off sulphurous gas, and sulphuric acid in vapours, which are easily neutralized.

The author next describes the laboratory. This contains; first, five platina boilers, arranged under a cover, which can be shut by three sliding doors, and which is ventilated by the main chimney of the laboratory; secondly, two round boilers, to dry the silver after precipitation; thirdly, three wind-furnaces, to fuse and granulate the ingots, and to melt the gold and refined silver in; fourthly, two square leaden boilers, to precipitate the sulphate of silver in, by means of copper; fifthly, a reservoir of water, for washing the different utensils in; sixthly, ten double crystallizing vessels, made of lead, for making the sulphate of copper in; seventhly, a square leaden boiler, for concentrating the sulphate of copper in; eightly, a main chimney, which is placed in the centre of the laboratory; and, ninthly, an apparatus, placed in the vaults beneath, to condense the sulphureous and sulphuric vapours, produced from the platina boilers. It is this last apparatus especially which characterizes the salubrity introduced in this art of refining. In fact, the platina boilers are furnished with heads to them, which communicate, by leaden tubes, with a series of leaden chests, in which the sulphuric acid condenses. The sulphurous gas, which escapes from the chests, is carried to a cylinder, with an agitator in it, kept in continual motion, and which cylinder contains hydrate of lime suspended in water; a current of air is established in this apparatus, by means of an opening made in the neck of each of the platina boilers, and by the communication from the boilers with the main ventilating chimney, after passing through the condensing chests and moveable purifier.

D. B. F.

LXV.—*On an admirable Mechanical Paradox, By Mr.* I. Lukens, *Engineer,* U. S.

We believe our readers will give us credit for the emission of divers wonderful projects, such as pretended perpetual motions, machines for gaining power, &c., with which, nevertheless, other works of recent date abound; and, in fact, we had much rather lend our aid in detecting and exposing such fallacies, than assist in propagating them, to the injury of real science.

We must, however, now plead indulgence, for stating some paticulars of an admirable mechanical paradox, which has perplexed most of the scientific persons who have seen it, and has indeed excited great interest to learn the construction of it.

We have repeatedly seen Mr. Lukens pass a knife-blade entirely through the ivory head of a cane or walking-stick, yet without effecting a separation of the parts, since his arrival in this country, with much surprise; but we have now actually had another carved ivory head of his construction in our possession for several days, and have repeatedly, as well as our friends, passed a knife backwards and forwards through it, from the chin to the back of the neck, and the contrary, without effecting any separation! We are under promise not to take the head to pieces, with a view to learn the construction of the mechanism of its construction, and which promise we shall of course not violate; so that our readers must, for the present at least, remain ignorant thereof.

We can, however, state, that the knife, in its progress through the neck, meets with two obstructions, each of which gives way, on being pressed a little, by urging the knife forwards; so that the artifice seems to consist in the ingenious construction of two spring-catches, one or other of which constantly has hold of the parts; and that whilst the knife, for instance, separates the front catch, the hinder one retains its hold; and again, when the knife reaches this, the front catch has again seized and secured the parts from disjuncture.

The face is carved into the representation of a sort of sneer, as it were, seeming pleased at the failure of the attempts made to separate the head from the neck. The neck is one inch in thickness, and one and three quarters of an inch broad, and the blade of the knife is three-sixteenths of an inch broad, and is made thin, with the edges rounded. No passage of the knife can be effected, in endeavouring to carry it through the neck sideways, but only from back to front, or the reverse, as above stated.

We are sure we shall be excused for thus bringing this truly ingenious piece of mechanism before the notice of our readers; and have reason to believe, that Mr. Lukens will not return to the United States, without leaving some one intrusted with the secret of it, and who will be capable of manufacturing it here.

LIST OF PATENTS FOR NEW INVENTIONS,

Which have passed the Great Seal since July 25, 1827.

To Edward Dodd, of No. 62, Berwick-street, near Oxford-street, in the county of Middlesex, musical instrument maker; for certain improvements on piano-fortes. Dated July 25, 1827. —To be specified in six months.

To Thomas Peek, of Saint John-street, Clerkenwell, in the parish of St. James, Clerkenwell, in the county of Middlesex, engineer; for a new engine, worked by steam, which he intends to denominate a revolving steam engine. Dated August 1, 1827. —In six months.

To William Parkinson, of Barton-upon-Humber, in the county of Lincoln, gentleman; and Samuel Crosley, of Cottage-lane, City-road, in the county of Middlesex, gas apparatus manufacturer; for an improved method of constructing and working an engine for producing power and motion. Dated August 1, 1827,—In six months.

To Joseph Maudslay, of Lambeth, in the county of Surrey, engineer; for a certain improvement on steam-engines. Dated August 1, 1827.—In four months.

To Lionel Lukin, of Lewisham, in the county of Kent, Esq.; who, in consequence of a communication made to him by foreigners abroad, and discoveries made by himself, is in possession of certain improvements in the manufacture of collars for draught and carriage horses, and saddles for draught, carriage, and saddle horses. Dated August 1, 1827.—In six months.

To Eugene du Mesuil, of Soho-square, in the county of Middlesex, Esq.; for an improvement or improvements on, or additions to stringed musical instruments. Dated August 1, 1827. —In six months.

To Anthony Scott, of Southwark Pottery, in the county of Durham, earthenware manufacturer; for an apparatus for preventing the boilers of steam-engines and other similar vessels of capacity becoming foul, and for cleaning such vessels when they become foul. Dated August 4, 1827.—In two months.

To John Underhill, of Parkfield Iron Works, near Wolverhampton, in the county of Stafford, iron master; for a certain improvement in machinery or apparatus for passing boats and other floating bodies from a higher to a lower, or from a lower to a higher level, with little or no loss of water, and which improvements are also applicable to the raising or lowering of weights on land. Dated August 13, 1827.—In six months.

To Peter Burt, of Waterloo-place, in the parish of St. Anne, Limehouse, in the county of Middlesex, mathematical instrument maker; who, in consequence of a communication made to him by a certain foreigner residing abroad, is in possession of an invention of an improved steam-engine. Dated August 4, 1827.—In six months.

To William Dickinson, of Bridge-street, Southwark, in the county of Surrey, tin-plate merchant; for an improved buoyant bed or mattrass. Dated the 13th of August, 1827.—In six months.

To Thomas Breidenback, of Birmingham, in the county of Warwick, merchant; for certain improvements on bedsteads, and in making, manufacturing, or forming articles to be applied to, or used in various ways with bedsteads, from a material or materials hitherto unused for such purposes. Dated August 13, 1827.—In six months.

To William Alexis Jarrin, of 123, New Bond-street, in the county of Middlesex, Italian confectioner; for certain improvements in an apparatus for cooling liquids. Dated August 13, 1827.—In two months.

To William Chapman, of the town and county of Newcastle-upon-Tyne, civil engineer; for a certain improvement or improvements in the construction of waggons that have to travel on rail-ways or on tram-ways, Dated August 14, 1827.—In two months.

To Henry Pinkins, of Philadelphia, in the State of Pennsylvania, in the United States of North America, but now resident at the Quadrant hotel, Regent-street, in the county of Middlesex, gentleman; for his improved method or apparatus for generating gas, to be applied to lights and other purposes. Dated August 15, 1827.—In six months.

To William Spong, of Aylesford, in the county of Kent, gentleman; for an invention for diminishing friction in wheel carriages, water-wheels, and other rotary parts of machinery. Dated August 15, 1827.—In six months,

To Lemuel Wellman Wright, of Mansfield-street, Borough-road, in the county of Surrey, engineer; for certain improvements in machinery for cutting tobacco. Dated August 21, 1827.—In six months.

To Lemuel Wellman Wright, of Mansfield-street, Borough-road, in the county of Surrey, engineer; for certain improvements in the construction of cranes. Dated August 17, 1827.—In six months.

GILL'S

TECHNOLOGICAL REPOSITORY.

LXVI.—*On Splitting, Cutting, and Polishing Diamonds, and on forming, mounting, and using Engravers', Glaziers', and Writing Diamonds, Diamond Dust, &c. By Mr.* EDMUND TURRELL, *Engraver.*

WITH FIGURES.

(*Continued from p.* 135.)

BEFORE I quit the subject of watch jewelling, I shall observe, it frequently happens that some splinters of diamond, which, from the shape of their points, are admirably adapted to make drills, are nevertheless unfit for the purpose, on account of the thickness of the stem behind the point; on which account they would make a conical hole in a ruby or other stone, too obtuse for general purposes. Such splinters, when used for diamond drills, must be soldered in a piece of iron wire, as before described; and being fixed in the mandrel of a lathe, they may be made smaller by holding or pressing another piece of *bort*, having a sharp edge, against the part that it is wished to reduce; by which means the back part of the drill will be made cylindrical, and of any convenient size.

On Engravers' Diamonds.—Copper-plate engravers frequently find it necessary to increase the strength of their tints, by re-entering the lines with a point; and some few years since, the only tool used for that purpose was the common steel etching point, whetted sufficiently blunt or obtuse for the purpose. These were very objectionable, on account of their liability to wear, by which circumstance, the tints, formed by lines so treated, were rendered very uneven. The late

Mr. Wilson Lowry, the celebrated engraver, conceived the happy idea of having small splinters of diamond turned in the lathe: the piece of diamond when finished being conical, with its point nicely rounded. Two of these points soldered into a piece of steel wire are shown in plate VII., fig. 1. The method of turning them was precisely the same as that above described for reducing the thickness of the diamond drills. Diamond points of this kind, and of various sizes, are now commonly used, and are found exceedingly useful for the purpose before named. These points, when made very fine, have been used to etch the bold lines in the fore-grounds of landscapes, and for other foliage; and they have also been found very serviceable in ruling tints in the ruling-machine, that are intended to be bitten very dark, the common splinters of diamond being too fine and keen for the production of bold dark lines, although they are requisite in all cases where delicate lines are wanted.

On Diamond Turning-tools.—John Barton, Esq., of the royal Mint, whose exquisite dividing is so well known, has of late years employed the diamond as a turning-tool with great success. The shape he prefers is shown by a top and side view of it in fig. 2. The upper plane surface of it has been produced by cutting and polishing it. This simple method of producing a turning-tool has great advantages; for as the whole of the diamond is left in its natural state, except the plane surface produced, it follows that the cutting-edge will be formed on the natural or external coat or surface of the stone, which in practice is found to be so much harder than the internal part. Diamonds, naturally formed of an egg shape, are the best suited for this purpose. It was with a tool of this description that Mr. Barton, some time since, undertook to turn off from a cylindrical surface a quantity equal to the 12,000th part of an inch, and which he perfectly accomplished for his friend, Mr. Edward Troughton, F.R.S.

Some persons have preferred having the diamond cut into the same form as the steel tool used for turning. Mr. Peter Keir, engineer, of Camden Town, had one constructed of the shape shown by a top and side view in fig. 8; which shape will answer extremely well, provided a quantity sufficiently small is taken off the metal to be turned at each cut. It may be necessary to observe, that diamond turning-tools are always used when fixed in a slide-rest, which regulates the quantity to be turned or cut off to the greatest nicety. One of the peculiar advantages in using the diamond as a turning-tool, is its capability of cutting hardened steel, which it does even in its most extreme degree of hardness.

On Diamond Ploughs for Engravers.—A machine was some years since contrived by Mr. Cosmo Armstrong, a celebrated engraver, which, instead of ruling tints of lines on copper-plates with a diamond point, was made to hold a steel graver or cutter, and tints of lines were cut in at one operation, which might be again re-entered and brought up to any degree of strength, by setting the cutter deeper at pleasure. A machine of this kind, upon a more extended plan, was constructed for R. H. Solly, Esq., F. R. S., a member of the Society of Arts, by the late ingenious Mr. James Allan, mathematical instrument maker; and in order to avoid the inconvenience arising from the wear of the steel-cutter, a diamond one was substituted for it, similar in shape to a graver, and which answered the purpose most admirably.

These few remarks will, I trust, be sufficient to show the value of the diamond, both as a cutting and turning-tool, where great durability is requisite.

On Jewelled Draw-plates for Wire.—There is no department of the arts or manufactures, where durability in the materials of which the principal tools are formed is of more consequence than in the process of drawing wire; especially that of the finest description. I shall now call the attention of your readers to a very ingenious application of the ruby, invented by the celebrated Mr. William Hardy, for equalizing the steel pendulum wire used for chronometers.

Fig. 4 represents a brass frame, in which the two dovetailed steel slides *a* and *b* are placed. The one at *b* is made fast, and is always kept stationary by the screw seen near *b*, which passes through it, and enters the brass frame. The one marked *a* is made to slide in the dovetailed groove formed upon the brass frame. The motion of it is regulated by a steel screw, the broad head of which enters partly into a notch or recess made underneath the slider, as shown at *c*. This will be better understood by refering to *c*, in fig. 5, an edge view of it, where the head of the screw is seen as bearing against one side of the notch, the tapped part of the screw entering the brass frame, as shown by the dotted lines. The two ends of the sliders, *a* and *b*, which are made to approach each other, have each a small plate or piece of ruby, slightly rounded, or made cylindrical externally, and fixed in a cavity or recess formed in the slides by cement; and between these two ruby surfaces the pendulum-wire is drawn, until it is not only equalized in its thickness, but also receives a most beautiful polish.—*d*, in fig. 6, is a steel-piece fixed to the brass frame by a screw and steady pin immediately above, and bearing upon the two dovetailed sliders before named; and *e* is a sliding steel bar, which is confined by the two screws seen at *f f*; but when the screws are slackened, it may be pressed closer towards *d*, the apertures through which the screws pass being made in the form of oval slits for that purpose. Each of these appendages, *e* and *d*, have also a ruby plate let into their ends; and being carefully cemented, they are then used to equalize the edges or sides of the wire, which produces a degree of perfection unattainable by any other means. Fig. 7 shows a section of the brass frame, with a piece of the pendulum-wire between the ruby plates. Fig. 8 is a plan and view of the steel sliding bar *e* detached; and fig. 9 is a plan and end view of the steel piece *d*, also detached: in both of which figures the position of the ruby plates may be distinctly seen in the end views.

My ingenious friend, Mr. William Brockedon, has obtained a patent for drawing cylindrical gold, silver, or other wire through holes made in rubies and other hard stones, amongst which the chryso-beryl was found very useful. The holes were either drilled with the diamond-drill, or *bort* in powder, as above described. As a proof of their great utility, I have heard him state, that a quantity of wire, equal to twelve miles in length, was drawn through a ruby hole without any sensible variation in point of size throughout its whole length.

(*To be continued.*)

LXVII.—*On using Cast-Iron for Corn-Mill Spindles and Steps, Brands, &c. By Mr.* J. MORTON POOLE; *with Remarks by the* EDITOR*.

SIR, *Brandywine, Jan.* 1, 1827.

I HAVE been a miller for nearly forty years, and for the last sixteen years of the time I have made use of cast-iron extensively in the corn-mills that I have been, and am now engaged in, for wheels, gudgeons, and spindles, as well as for steps for those spindles, all which are cast-iron throughout; the cock-head, neck, and foot of the spindles being formed all of the same metal, cast at the same time, and all have worn very well for sixteen years past, having given us but little trouble. Had I now a new mill to build, I should use the cast-iron spindles, &c., in preference to any others.

It has occasionally been necessary, indeed, to introduce new steps, as they bore down faster than the feet of the spindles wear; but this has occasioned us little trouble, as we have a pattern of wood provided, and several extra steps at hand, which we place under the spindles rough as they come from the founder (except cleaning out the sand that had adhered to the iron in casting), adding a small quantity of ground emery and oil put in the steps; they are then ready for work in the usual way.

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* From the *Franklin Journal*.

Our brands* have their heads also made of cast-iron, and they have been found to answer our purpose well for many years, by changing them as they are worn out: this is done very readily, as we have always some to spare, they being prepared at the furnace with a wrought-iron bar about fifteen inches long cast in each head, to which we weld the old handle when we find it necessary to make use of a new brand.

I need not make any further observations, than that the steps of the spindles ought to be of the hardest cast-iron†: and in relation to the brands, that in casting them, the end of the bar of wrought-iron should be split into four parts for an inch, and be opened a little, and the brand be cast upon that end to prevent their becoming loose, which they are likely to do without this precaution.

A cast-iron brand only costs about half as much, and will last about half as long as one that is forged and cut as usual. But there is, in various respects, a great advantage in having two brands instead of one.

To Dr. THOMAS P. JONES. J. MORTON POOLE.

Remarks by the EDITOR.

We have long known the good effects of wrought-iron mill-spindles *steeled* on their necks or pivots and hardened, running upon *chilled cast-iron* journeys, but not *cast-iron* upon *hard cast-iron*, as herein described. This is a new fact to us, and an important one; and coming from so respectable an authority as the proprietors of the Brandywine corn-mills, must be unquestionable.

The cast-iron journeys here spoken of by us had their semi-cylindrical cavities, in which the cylindrical necks of the spindles ran, *chilled* in the casting, by means of semi-cylindrical blocks of cast-iron placed in the sand mould; and they were so very hard, that emery applied upon lead, as usual, made so little impression upon them, that they were put to work from the casting, and it was a long time before any perceptible wear was effected upon them. They, however, always caused the spindles to run *perfectly cool,* by the use of grease applied to them as in common.'

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* Or marking-irons, used in marking casks of flour, &c.

† Brasses are used in this country for steps.—EDITOR.

We are not aware that the *hard cast-iron* mentioned by Mr. Poole was *chilled;* most probably not, as he speaks of the necessity of removing "the sand that adhered to the iron in casting." Now, in *chill-casting* upon *metal blocks* laid in the moulds, no such adherence of sand can take place, they being *perfectly clean iron.* We would therefore recommend this useful practice to be employed in casting the *steps* for the corn-mill spindles, by placing a *hemispherical cast-iron block* in the sand moulds, to form the cavity for the foot of the spindle to turn in.

LXVIII.—*On a new Electro-Magnetic Apparatus, invented by Mr.* FRANCOIS WATKINS, *Philosophical Instrument-maker.*

WITH A FIGURE.

SIR, 5, *Charing-cross, London, Sept,* 19, 1827.

I BEG leave to communicate, for insertion in your *Technological Repository,* a new electro-magnetic apparatus of my invention, it being, I believe, the first time that a helical coil of wire has been made to revolve round a magnet.

I consider that it affords a better example of the revolving wire than has hitherto been shown, and certainly has a more pleasing effect than that produced by the revolution of a straight wire. Should any of your numerous readers wish to see it in action, I shall at all times be happy to show it to them. I remain, sir, your obedient servant,

To T. Gill, Esq. FRANCIS WATKINS.

A Description of a new Form of Revolving Wires around the Poles of a Horse-shoe Magnet, produced by Electro-Magnetism.

In the 43d vol. of the Transactions of the Society of Arts, &c., there is described an apparatus for showing a similar effect, by Mr. Sturgeon, produced by straight wires suspended from above, and their lower ends dipping into and revolving in two circular cups containing mercury. My alteration consists in the substituting of helical coils of copper wire, having slender bars soldered across their tops with needle points in their centres, turning in conical holes, drilled in the ends of the magnet, which is formed of a cylindrical rod; and above the points two small platinum cups are affixed, to hold a globule of mercury in each. Two wooden cups are attached by screws on the lower parts of the magnet, having bent arms fixed in them, and small cups upon the external parts of them. To the lower ends of the helical coils are soldered slender pointed wires, bent so as to enter slightly into mercury placed in the two larger cups, and mercury is also placed in the small cups.

A brass standard affixed to the basis of the apparatus has a forked piece attached to it, with two points descending into the two platinum cups upon the tops of the coils; and there is also another cup placed upon the forked piece to contain mercury. The voltaic circuit is then completed, by placing wires in the mercury contained in the small side cups, and connected with the copper parts of the batteries; and other wires, communicating with the zinc parts, are placed in a cup on the top of the apparatus. When the voltaic action commences, the helical coils will be seen to revolve rapidly in contrary directions; but on changing the disposition of the connecting wires, the revolutions of the coils will be reversed.

Any form of voltaic battery may be used, but I prefer for all electro-magnetic experiments that described by Mr. Sturgeon in the work above referred to.

References to the Engraving.

In plate VII. fig. 10 is a perspective view of the apparatus.—A is the horse-shoe magnet, firmly screwed to a wooden basis or support; B B, the two helical coils of copper wire; C C, the bars across their tops, from which needle points descend into conical holes, formed in the centres of the hemispherical ends of the cylindrical magnet; D D, the small platinum cups above the needle points; E E, two wooden cups, affixed by adjusting screws upon the lower parts of the magnet; F F, two smaller wooden cups; G, a pillar affixed to the basis, within which slides the stem of the forked piece H, which has two points made to descend into the platinum cups, and a central cup upon it, I; J is an adjusting screw in the pillar G, to regulate the height of the points of the forked piece H; K K, the pointed wires soldered to the lower ends of the helical coils of wire.

LXIX.—*On an excellent Smoke Consumer for Argand Lamps.*

WITH A FIGURE.

THIS very useful and simple apparatus has been employed for several winters past, with complete success, by Messrs. Watkins and Hill, of Charing-cross, who had it from Benjamin Wyatt, Esq., he having originally brought it from France, and where it is still in constant use.

It is composed of a thin convex plate of copper affixed to a flat circular ring of sheet-iron, the rim of the copper plate being burnished over its rim or edge. Into this iron ring three iron wires are firmly affixed, by being first passed through three equi-distant holes made in the ring, and their ends bent and again passed through three other holes likewise made in the ring, near the former ones, to receive them, and into which they are riveted. This is done to prevent the wires from turning in the holes. The wires are then doubly bent, as shown in the figure, so as to fit the inside of the glass chimney of an argand lamp, and to lodge or rest upon the rim of it, the cap being supported at the height of an inch above the top of the chimney.

The iron ring is two inches and five-eighths in diameter externally, half an inch broad, and one inch and five-eighths internal diameter.

Without attempting to account for the cause of the beneficial effect of these smoke consumers, otherwise than by supposing that the carbon of the smoke is consumed by the heat of the flame acting upon the metal placed immediately above it, and upon which the smoke is lodged for an instant, we can only say that the ceiling immediately over the lamps does not show the least appearance of any deposition of carbon having taken place upon it for upwards of two years! We may therefore infer that this apparatus most completely performs the office of a smoke consumer.

Upon taking one of them asunder, which had been long in use, it appeared that the copper plate had been very considerably heated, it being covered with a complete coat of oxide. Messrs. Watkins and Hill have likewise applied these smoke consumers to the argand lamps employed in their improved magic-lanterns with complete success.

References to the Figure.

In plate VII., fig. 11 is a section of the apparatus.—*a*, part of the glass chimney of the lamp; *b b b*, the three bent iron wires resting upon the top of the chimney, and supporting the copper cap *c*, affixed to the flat circular iron ring *d*.

LXX.—*Facts and Observations on the Bursting of the Boilers of Steam Engines. By* ERSKINE HAZARD, *Esq. Civil Engineer* *.

SIR, *Philadelphia, April* 16*th*, 1827.

THE frequency of disasters arising from the bursting of boilers in steam boats, both with high and low pressure engines, makes it the imperious duty of all those who have given particular attention to the subject, to make public any ideas which may throw light on the cause of them, as they may thereby aid in preventing their repetition. With this view I take the liberty of sending you the following explanation, which was given me by my countryman Perkins. He builds his theory on the ground that the power of steam does not depend upon temperature alone, but principally upon the quantity of water that is contained in a given bulk of it; in other words, that its power is derived from its compression. This corresponds with the experience of the late Colonel Alexander Anderson, who gave me the same theory many years since; and at the same time informed me, that when distilling by steam, he uniformly found the quantity of liquor produced in a given time to be in exact proportion to the pressure within his still. He hence concluded, that atmospheric steam, confined within any vessel in such a manner that it could not get an additional supply of water, might be heated red-hot without bursting the vessel or increasing its power. Mr. Perkins states that he has completely realised this idea in his experiments. He also mentions a fact communicated to him by Mr. Williams, principal manager of the Dublin and Liverpool steam company, which was this: The people on board one of the boats were alarmed, while on their voyage, by the smell of *pine* smoke, and concluded that the boat must be on fire; but upon searching, they found a piece of pine wood on the top of one of the boilers, which was nearly burnt to a coal; it was in such a situation that no fire could have communicated with it, except through the top of the boiler. The engine at the time was working with steam, only a few pounds above the atmospheric pressure. Upon mentioning this circumstance to the captain of one of our Delaware steam-boats, he informed me that the leaden joints of his steam-pipe were once melted, when the steam-guage indicated only the pressure at which they usually worked. In both these cases the water was so low in the boilers, that the heat was communicated to the steam through a portion of the boiler which had no water in contact with it, and which of course became red-hot, while the steam could not part with its heat downwards to the water.

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* From the *Franklin Journal.*

The repellent power of heat is the proximate cause of explosion, according to Mr. Perkins's theory. This was one of the principal obstacles he met with in the progress of his experiments on high-pressure steam. In his tubular generators he found it impossible to keep the water in contact with the metal, when a great heat was applied, until he adopted the expedient of the pressure valve, loaded with five atmospheres more than the pressure of the steam. The water was, as it were, wire-drawn, or passed through the centre of the tubes in a fine thread, being repelled by the heat of the sides, which increased to redness, and finally destroyed the tubes. To show this repellent power of heat, he made a hole of one quarter of an inch diameter in one of his generators and adapted a plug to it, which was removed when that part of the tube became red-hot; no steam nor water escaped from the hole, notwithstanding the steam-guage indicated a very high pressure: a wire was introduced into the hole to ascertain that it was free; the generator was then suffered to cool to a black heat, when the steam commenced issuing from the hole with great violence. Another experiment was, to heat two cast-iron bowls, of equal dimensions, the one black the other red-hot, and then to pour equal quantities of water into both; the cooler bowl uniformly evaporated the water first. I have frequently noticed very hot pieces of iron, when thrown into a blacksmith's slack-trough, lie red-hot for some time under the water, apparently surrounded by an atmosphere of heat, without throwing any steam up to the surface of the water. This will never be the case if the tongs be plunged into the water with the hot iron, as their heat, in some parts of them, is only sufficient to raise steam, and not sufficient to prevent the water from coming into contact with them, and through them with the whole mass successively. From the above facts, Mr. Perkins's explanation of the bursting of boilers will, I think, appear very plausible; it is this, that the water is suffered to get so low, as to bring a portion of the boiler, not covered with water, in contact with the fire; this becomes red-hot, and imparts its heat to the steam; the redness gradually extends itself below the water, which is at length repelled from the boiler and thrown up among the hot steam (like a pot suddenly boiling over), which surcharged steam, immediately imparting its excessive heat to the water, forms steam of the greatest power, and occasions the disastrous explosions.

In the late accident on board the Oliver Ellsworth steam boat, it seems to be impracticable to ascertain what was the state of the water in the boiler; but supposing it to have been at the proper height, may not the motion of the vessel, from a head-sea, have left portions of the boiler exposed to the fire for a length of time sufficient to make them red-hot, and the above theory be thus rendered perfectly applicable? Should this be the fact, it appears to me an additional security would be obtained by having the boiler divided by partitions, which, though not tight enough to prevent a regular communication from the supply-pump and steam-pipe to every part of the boiler, would still be sufficiently so to prevent the water from rushing in a body from one extremity to the other, and thus leaving portions of the boiler unprotected from the fire. These partitions might be constructed of rough boards, in such a manner that they could be removed when the boiler required cleaning, and would rather favour than retard the process of making steam.

The bursting of the boiler of the Ætna was attributed to the supply-pipe being choked. To this, then, the theory is perfectly applicable,

I am, sir, your obedient servant,

To Dr. THOMAS P. JONES. ERSKINE HAZARD.

LXXI.—*On the different Black Colours. By the late celebrated* WILLIAM LEWIS, *M.B. and F.R.S.*

(*Continued from p.* 180.)

SECTION V.

Black Paints, Varnishes, &c.

Composition for preserving Wood, &c.—The mixture of tar and lampblack is found the most effectual preservative for the masts and yards of ships. Such parts of the mast as the sliding up and down of the sails requires to be only greased, and those which are covered with turpentine, or resin mixed with tallow or oil, generally contract large rents; while the parts coated with tar and lampblack remain perfectly sound. I have been favoured by a gentleman on board of a vessel in the East Indies with an account of a violent thunder storm, by which the mainmast was greatly damaged, and whose effects on the different parts of the mast were pretty remarkable. All the parts which were greased, or covered with turpentine, were burst to pieces; those above, between, and below the greased parts, as also the yard-arms, the round-top, or scaffolding, &c., coated with tar and lampblack, remained all unhurt.

In this place it may be proper to observe, that the coating or painting of wood does not, in all cases, contribute to its preservation, unless the wood be very thoroughly dry; especially those kinds of wood whose juices are not oily or resinous, the painting, by confining the watery sap, hastens the corruption. Several presses, for a paper manufactory, having been made of heart of oak, seemingly very dry, some of them, which with injudicious care had been well painted over, rotted and perished in a very few years, while the unpainted ones continued for many years perfectly sound.

Compositions for blacking Leather.—In the tanning of leather, it is so much impregnated with the astringent parts of oak bark, or with that matter which strikes a black colour with green vitriol (sulphate of iron), that rubbing it over three or four times with a solution of the vitriol, or with a solution of iron made in vegetable acids, is sufficient for staining it black. Of this we may be convinced by dropping a little of the solution on the unblackened side of common shoe-leather. This operation is performed by the currier, who, after the colouring, gives a gloss to the leather with a solution of gum arabic and size, made in vinegar. Where the previous astringent impregnation is insufficient to give a due colour, and for those sorts of leather which have not been tanned, some galls or other astringents are added to the solution of iron; and in many cases, particularly for the finer sorts of leather, and for renewing the blackness, ivory or lampblack are used. A mixture of either of these with linseed oil makes the common oil blacking. For a shining blacking, small beer or water are taken instead of oil, in the quantity of about a pint to an ounce of brown sugar, and as much gum arabic. The white of an egg, substituted for the gum, makes the black more shining, but is supposed to hurt the leather, and make it apt to crack*. It is obvious that all these kinds of compositions admit of many variations; it is sufficient here to have given a general idea of them.

Spirit Varnish.—Black varnish, for japanning on wood or leather, is prepared by mixing lampback or ivory-black with a proper quantity of a strong solution of gum lac in spirit of wine highly rectified. The lamp-black is commonly preferred to the ivory-black, on account of its uniting better with the fluid, and working smoother. The thicker part of the varnish, which settles at the bottom, is used with the lamp-black for the first coatings, and the mixture applied at different times, in a hot room, one layer after another, till a full body of colour is obtained; after which the piece is washed over, in the same manner, several times, with the finer part of the varnish, just tinged with the black, so as to make a coating of sufficient thickness to bear polishing with tripoli.

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* Not however in the degree which the modern refinement of adding *sulphuric acid* to the blacking now occasions.—Editor.

Amber Varnishes for Papier Maché, &c.—Papier mache is made of cuttings of white or brown paper boiled in water, and beaten in a mortar till they are reduced into a kind of paste, and then boiled with a solution of gum-arabic or of size to give tenacity to the paste, which is afterwards formed into different toys, &c., by pressing it into oiled moulds*. When dry, it is coated with a mixture of size and lamp-black, and afterwards varnished.

The black varnish for these toys is prepared as follows:—

Some colophony, or turpentine, boiled down till it becomes black and friable, is melted in a glazed earthen vessel, and thrice as much amber in fine powder sprinkled in by degrees, with the addition of a little spirit or oil of turpentine now and then: when the amber is melted, sprinkle in the same quantity of sarcocolla, continuing to stir them, and to add more spirit of turpentine till the whole becomes fluid; then strain out the clear through a coarse hair bag, pressing it gently between hot boards. This varnish, mixed with ivory-black in fine powder, is applied in a hot room on the dried paper paste, which is then set in a gently heated oven, next day in a hotter oven, and the third day in a very hot one, and let stand each time till the oven is grown cold. The paste thus varnished is hard, durable, glossy, and bears liquors hot or cold.

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* In Paris, however, a more *economical* mode of procuring the materials for *papier maché* is now adopted, the walls being diligently stripped of the *posting bills*, which thus afford both *paper and paste* for the moulding of snuff-boxes, &c. &c.—Editor.

A more simple amber varnish of great use for many purposes, and said to be the basis of the fine varnishes which we see on coaches, &c., is prepared by gently melting amber in a crucible till it becomes black, then reducing it into a powder, which looks brown, and boiling the powder in linseed oil, or a mixture of linseed oil and oil of turpentine. Drying oil is commonly made choice of by the workmen; but it seems more eligible here to take the oil unprepared, that the boiling requisite for giving it the drying quality may be employed at the same time, in making it act on the amber.

By the previous melting of the amber, its nature is changed, and part of its oily and saline matter expelled, as happens in the common distillation of it. When the distillation is not far protracted, the caput mortuum, or shining black mass which remains in the retort, answers as well as the amber melted on purpose. Hence some of our chemists, instead of urging the distillation to the utmost, by which the amber would be reduced to a mere coal, find it more advantageous to discontinue the process when the thinner oil and greater part of the salt have arisen, that the remaining mass may be in great measure soluble in oils, so as to supply the common demand of the varnish makers.

It has generally been thought that amber will not at all dissolve in oils till it has thus suffered a degree of decomposition by fire. Hoffmann relates an experiment in his " Observationes Phisico-Chemicæ," which discovers the solubility of this concrete in its natural state. Powdered amber, with twice its quantity of oil olive, was put into a wide-mouthed glass, and a digestor, or strong copper vessel being filled about one-third with water, the glass was placed in it, and the cover of the digestor screwed down tight, and a moderate fire continued an hour or more; when cold, the amber was found dissolved into a gelatinous transparent mass.

In Dr. Stockar's very curious "Specimen Inaugurale de Succino," printed at Leyden in 1760, there are sundry more important experiments on this subject made by himself, conjointly with my worthy correspondent, Mr. Ziegler, of Winterthur. They found that by continuing a simmering heat twelve hours, and confining the vapours as much as stone-ware vessels would bear without bursting (the danger of which was avoided by making a small notch in the cork stoppers), powdered amber dissolved perfectly in expressed oils, in turpentine, and in balsam of copaiba: a strong copper vessel, with a cover screwed on it, seems most eligible; and for the greater security, a valve may be made in the cover, kept down by a spring, that shall give way before the confined vapour is of sufficient force to be in any danger of bursting the vessel. Though such a heat as converts part of the oil into strong elastic vapours, and the forcible compressure of the vapour, are expedient for hastening the dissolution, they do not appear to be essentially necessary; for by digestion for a week in close-stopped glass vessels, in which the compressure could not be very great, solutions equally perfect were obtained.

The solutions in rape-seed oil, and in oil of almonds, were of a fine yellowish colour; in linseed oil, gold coloured; in oil of poppy-seeds, yellowish red; in oil olive, of a beautiful red; in oil of nuts, deeper coloured; and in oil of bays, of a purple red. It is observable that this last oil, which of itself, in the greatest common heat of the atmosphere, proves of a thick butyraceous consistence, continued fluid when the amber was dissolved in it. The solutions made with turpentine, and with balsam of copaiba, were of a deep red colour; and on cooling, hardened into a brittle mass of the same colour. All the solutions mingled perfectly with spirit of turpentine.

Those made with the oils of linseed, bays, poppy seeds, and nuts, and with balsam of copaiba and turpentine, being diluted with four times their quantity of spirit of turpentine, formed hard, tenacious, glossy varnishes, which dried sufficiently quick, and appeared greatly preferable to those made in the common manner from melted amber.

Black Varnish for Metals.—Iron snuff-boxes, mourning buckles, &c., are coloured black by making them considerably hot, and applying on them, in this state, a thick mixture of lamp-black, with a certain varnish called gold-size, consisting of drying oil, turpentine, and the pigment called Naples yellow; which last ingredient is used for giving a high gold colour to the mixture, to fit it for some of the other purposes for which it is employed. In the present intention the yellow might doubtless be omitted, and the varnish formed at once by mixing lamp-black with a proper quantity of turpentine and drying oil.

Black Sealing-Wax.—Black sealing-wax is composed of gum-lac melted with one-half or one-third of its weight of ivory-black in fine powder. The inferior sort of lac, called shell-lac, answers as well for this use as the finest. It is customary to mix with it, for the ordinary kinds of sealing-wax, a considerable portion, as two-thirds its weight, of the cheaper resinous bodies, particularly Venice turpentine, by which the beauty of the mass is here less injured than in the red wax, and of which a small addition is in all cases expedient to prevent the compound from being too brittle. The ingredients being melted and well stirred together over a moderate fire, the mixture is poured out upon an oiled stone or iron plate, and rolled while soft into sticks, which afterwards receive their glossiness by being heated till the surface begins to shine.

The black figures on the dial-plates of clocks, which look like black enamel, are formed of the finer kind of black sealing-wax, which is melted into cavities made in the plate, and afterwards polished. Black enamel, or be more effectually destroyed. It may, however, be questioned, whether additions of this kind are of much use; for I have prepared the varnish, seemingly of a very good quality, by fire alone.

There is another sort of addition whose effect is more apparent. To give a greater body to the varnish, and increase its drying quality, a proportion of turpentine is thought necessary; and with some artists litharge has in this intention been a secret. It is observed in the "French Encyclopedie," by M. le Breton, the printer of that work, that when very old oil is used, neither turpentine nor litharge are needful; but that, when the oil is new, some turpentine must necessarily be employed, for without it the smearing of the paper by the spreading or coming off of the ink cannot be avoided; that it is much more eligible to use old oil than to have recourse to this correction of the new; both turpentine and litharge, particularly the last, making the mixture adhere so firmly to the types that it is scarcely to be got entirely off by the ley, whence the eye of the letter is soon clogged up.

When turpentine is used it is first boiled by itself, until, on dipping in a piece of paper, it is found to crumble and part from the paper when cold; the oil being then taken from the fire, the turpentine, while still fluid, is poured into it, after which the boiling is repeated and continued till they are sufficiently incorporated. It is here somewhat more difficult to hit the due point of boiling than when the oil is prepared without addition, the mixture being more apt to grow too thick from continuing the heat too long, and is also full of little hard grains from not continuing it sufficiently; which grains are probably undissolved particles of the turpentine. The use of boiling the turpentine first by itself is to dissipate its moisture or essential oil; by the boiling it becomes a resinous matter, nearly the same with common resin, which possibly would answer the same end.

For making the varnish into ink, lamp-black is the common material; of which, according to M. le Breton, two ounces and a half are sufficient for sixteen ounces of the varnish. They are ground together on a stone with a muller, in the same manner as oil paints.

The paper for printing is moistened with water, by which it is made more yielding and pliable, so as not only to be less apt to be torn by the types in the press, but likewise to be more closely and evenly applied to them, and consequently to take a neater and more perfect impression. The due moisture of the paper, and the care and attention of the pressmen in well working the ink on the types with the balls, are very essential points, without which, however excellent soever the ink is, the impression will not be beautiful.

The adhesion of printers' ink to wetted paper seems to show that it is not truly of an oily nature. All expressed oils contain probably a gummy or mucilaginous matter; and perhaps the tenacity, conistence, drying quality, and the property of adhering to bodies moistened with water, which the oil acquires in the process above described, may be all owing to some of the purer part of the oil being destroyed, so as to leave the remainder more gummy. When the oil dries it proves to be a tough, flexible substance, which has little disposition to unite with fresh oil any more than with water, as if the gummy and oily matter were in such proportions that one defends the other from the menstruum that would otherwise dissolve it: essential oils, on the contrary, being free from gum, harden into a merely resinous mass, brittle like other resins, and which dissolves, like the oil at first, in fresh oil or in spirit of wine. The differences observed in different expressed oils, in regard to the drying quality, may depend on the different quantities of gummy matter; and the difference of old oil from new, on the gum being in the latter more intimately combined, so as not to separate in the burning and boiling. When these oils are first pressed out of the subjects they abound with mucilage, great part of which is only imperfectly mixed, so as to give a turbidness and opacity to the fluid; in keeping, a part of this loose mucilage is thrown off, and the remainder may be presumed to become at the same time more intimately combined with the oil. The repugnance which we observe between oil and gum does not in the least invalidate these conjectures, any more than the repugnance between oil and water can be an argument against the existence of water in oils; indeed we have plain proofs of the coalition of oil with gum in the analysis of the purest gums, gum arabic, seneca, and tragacanth, from which an actual oil is obtained by distillation. The distillation of expressed oils themselves seems to favour the opinion here proposed: from all of them there remains in the distilling vessel a large quantity, though from some more than others, of a gross coaly matter, and there arises a fluid oil which does not dry or grow thick in the air as the oils did at first, and which is therefore found to answer better for certain purposes, as in the lapidaries' business, for which the thickening of the oils in their natural state renders them useless.

Rolling-Press Ink.—Between the rolling-press printing and that of the printers' press, strictly so called, there is this essential difference,—that in the former the impression is received from figures hollowed in a copper-plate, but in the latter from prominent types. The damping of the paper is equally necessary for the rolling-press as for the others in order to soften it, so that the parts corresponding to the cavities in the plates may be forced into them; but the ink is of a somewhat different quality. For while the printers' types require a glutinous or sticky mixture which shall adhere upon the prominences of the type, without running into the hollows, the ink for copperplates must run into and fill the hollows, especially when the plate is warmed, and be so little glutinous as to be easily wiped off clean from the smooth parts of the plate, or those which are to leave the paper white.

The oil for this ink must be boiled and set on fire in the same manner as for the other, to take off its greasiness and promote its drying; the boiling is continued more or less according to the different consistencies which different kinds of plates may require, but never so far as to communicate to the oil the adhesive gluey quality of the printers' varnish. The black matter must be of the charcoal kind: the lamp-black gives always a degree of toughness, but the charcoal blacks, as they do not unite intimately with the oil, divide its texture and renders it less gluey. The coal commonly employed for this use is brought in powder from Germany, and called German or Frankfort black; this is softer and more free from grittiness than the ivory, or other charcoal blacks as usually prepared among us.

The Frankfort black is supposed by some to be the coal of vine-twigs; by others, that of the kernels of fruits and wine-lees burnt together. The coal of vine-twigs, as we have already seen, does not appear to differ in any great degree from that of the small branches of other kinds of trees; but the kernels of fruits yield a coal considerably more soft and mellow, easily crumbling between the fingers into a fine meal. That the Frankfort black is no other than a vegetable coal appeared from its burning on a red-hot iron, like charcoal powder, into white ashes; and from the ashes, like common vegetable ashes, being plentifully dissolved by the vitriolic acid into a bitterish liquor; while the ashes of animal substances are very sparingly affected by that acid, and form with it a compound of a different kind of taste.

(To be continued.)

LXXII.—*A Description of the American Marine Railway, as constructed at New York, by Mr.* JOHN THOMAS, *Civil Engineer; with Explanations of its Principle, and Manifestations of its Safety for Ships of War. By* JOHN L. SULLIVAN, *Esq. Civil Engineer.*

(Continued from p. 168.)

WITH A PLATE.

Report of the Committee of Inventions of the Franklin Institute of Pennsylvania, on the American Marine Railway, constructed by Mr. JOHN THOMAS, *of New York.*

THE Committee of Inventions, to whom has been presented the examination, by John L. Sullivan, Esq. of New York, civil engineer, a description, with drawings of a marine railway, exhibiting the improvements made by Mr. John Thomas, of New York, ship-builder.

Report.—That they are fully satisfied that the improvements made by Mr. Thomas add greatly to the security of a vessel, when drawn up on marine railways, for the purpose of being repaired, and obviate most of the difficulties which have attended the hauling up on ways heretofore constructed. The shear-shores possess a degree of stability which gives them a decided advantage over those of the ordinary form, and the facility with which they may be applied and adjusted appears to the committee a point of great practical importance. The support derived from the bilge-levers is well calculated to prevent that injurious strain to which a large vessel is liable when removed out of the water, without having her bilge supported; these levers form a cradle which admirably adapts itself to the shape of every vessel, whilst the facility with which these levers and the shear-shores may be successively removed, for the purpose of coppering, or of making other repairs, add much to their utility.

The committee do not enter into any particular detail upon this subject, as the description of drawings which accompany this report render such a detail unnecessary. The excellence of the structure is not a point of mere speculation, as a railway upon this plan has been in operation in New York for several months, and, it is believed, has completely fulfilled the expectations of the proprietors. A great number of vessels, of different sizes, have been drawn up, repaired, and re-launched, with perfect ease and safety. This railway was constructed under the direction of Mr. Thomas, and although it was the first trial of his improvements, his practical knowledge has been strikingly evinced in the firmness of those parts of the structure upon which the greatest strain falls, whilst the carriage is not loaded with a weight of materials which does not add to its strength.

The superiority of railways to dry docks, in several points of view, is acknowledged by all who are conversant with the subject. The dry dock is by far the most expensive in its construction, whilst humidity, darkness, and want of room, interfere materially in carrying on the requsite operations after a ship has been secured in it for repair. To obviate these objections, by increasing the size of the dock, would in most instances add so greatly to the expense of building, and of using it, as to prevent, on the part of the mercantile community, every attempt to establish them.

THOMAS P. JONES, *Sec.* ROBERT M. PATERSON,
Philadelphia, Jan. 10, 1827. *Chairman.*

References to plate VIII*.

Fig. 4, the lifting planes.—*a*, the keel of the ship; *b*, the upper block of the lifting planes; *e*, the under block; *d d*, the wedges; *e, f*, the block, in different points of view; *g g*, the battering rams.

Fig. 5, the improved dowelling bit.—*a* the chisel, *b* the cutter, of the old instrument; *c* the gouge, *d* the screw, of the improved implement.

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* The preceding figures are contained in plate VI. of our last number.

Fig. 6, the under-water implements and works.—*a a a a*, piles; *b*, a pile standing out of the water; *c c*, piles cut off to the line of the plane; *d*, a pile in the process of cutting off in the diving-bell; *e*, the level and bevel in the diving-bell; *f*, the batten and target; *g g*, the aerial plane, parallel to the intended plane; *h*, the surface of the water; *i*, compasses; *k*, the ground; *l*, the intended plane.

Fig. 7—*a*, the New York chain; *b*, Tucker's improved chain.

LXXIII.—*On the kind of Stones employed in Lithography, and on the mode of Polishing them*[*].

On the Choice of the Stones.—It is necessary to remark, that a lithographic establishment should be provided with stones of all dimensions, in order to enable it to execute work of all kinds. To the amateur who has only one particular design, and who is satisfied with the lever press, only a small number of stones is necessary. Two or three may suffice for him who confines himself to experiments or to one particular subject.

The country adjacent to that wherein lithography originated is abundantly provided with stones suited to this art. There are immense quarries of it, dispersed in layers, along the Danube, in the country of Pappenheim, and in several other spots. The principal quarries wrought are at a village called Solenhofen. Every one admitting the existence of a first cause, must believe, that Providence, who destined to this age the invention of an art favourable to the progress of civilization, had formed a considerable mass of stones ready prepared for the service of lithography. They are, in fact, found disposed in layers of one, two, three, or more inches in thickness, in such a manner, that it is merely necessary to raise them from the quarries, and to cut them into convenient sizes, their thickness being equal throughout in each strata. Nature, who acknowledges neither privilege nor monopoly, has distributed the same benefit amongst other countries also, though in a way less striking. Lithographic stones are found in France, Italy, Prussia, Britain, Spain, and in the United States. Researches made with greater care would undoubtedly discover them in a great number of places. France might do very well without stones from Solenhofen. The quarries discovered in the departments of the Indre, and in that of the Ain, and even in some other places, are sufficient for our necessities. All the lithographers of Paris make use, however, almost exclusively, of those from Germany. The reason of this is, that our quarries have been badly worked, either from want of funds or from ignorance The first masses which presented themselves on the superficial strata have been employed; these stones are full of hollows, veins, or other defects, though otherwise of a good quality, being harder than those of Solenhofen; they are excellent for writings, for drawings in ink, and for line engravings. Those of the first quality, from Germany, are preferred for designs in crayon; those found in commerce are not all equally good. The following are the properties which denote the goodness of a lithographic stone:—

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[*] From the *Franklin Journal*, translated from a late number of the *Journal des Connoissances Usuelles*, published in Paris by Count M. D. Lasteyrie, who has an extensive lithographic establishment, which is esteemed the second in that city.

White stones are generally inferior to other kinds, being less durable. Those of a yellowish, or rather a greyish tint, are to be preferred on account of their durability, and because their grain is generally most equal. Those which are covered with points, or little whitish parts resembling vermicella, ought to be altogether rejected, especially when it is necessary to make delicate drawings in crayon; as the marblings or shades of different colours deceive the eye of the artist, and prevent his giving to his work that effect and harmony which it ought to have. The strata with stripes of a more transparent tint than the rest of the stone ought to be rejected, not only because they are liable to split, but because they take the ink more readily in those parts, and leave the traces of it more strong upon the designs. Stones, however, are met with which have fine lines, or threads of a brownish hue, which do not present any impediments to the success of the artist.

Stones which are hard and homogenous acquire a more equal surface, and are better adapted to the harmony of the tints; they give a greater number of impressions without clogging, and furnish proofs more clear and brilliant, whilst the contrary is the case with those which are softer; the durability of a stone may be ascertained by scratching it with the point of a knife. Those which are soft retain with more difficulty the traces of the design in the light touches; they clog more readily, and consequently afford a smaller number of impressions. The metallic pen cuts them easily, which produces a clogging, and prevents the ink from flowing. The grain of these stones is always coarse and unequal. Those which have holes, or those which are unequal in their grain or in their hardness, present the same inconvenience; they check the point of the pen when employed in imitating line engraving, and do not admit of the artist giving clearness and neatness to his work. The soft parts being also more easily acted on by the acid are corroded, and injure the parts of the design with which they have been covered. Stones which have any defect whatever ought never to be used for the crayon, with which it is necessary to draw with particular care; they are therefore generally used for works in ink. The thickness of the stones is immaterial, provided they are not too thin; for in this case there is a risk of breaking them in the operation of printing. Their thickness ought to be proportioned to their surface; the smallest should not be less than an inch, when thicker they have the advantage of serving for a considerable number of designs; but they are very inconvenient when it is desired to remove or export them. It sometimes happens that a stone, the surface of which presents all the qualities which have just been spoken of, and which has succeeded well in the impressions of one or more copies, is found to be bad in the succeeding impressions.

The stones proper for lithography are composed of lime, argil, and silex. The first of these substances predominates; the third is found in very small quantity. A stone entirely calcareous does not answer for lithography, as has been proved by the marble of Carrara; the crayon and ink adhere to this stone with difficulty, and are readily effaced from it; the lines and the shades in a great measure disappear. One of the most certain indications of lithographical properties is the conchoidal fracture. All stones of this kind will be found good if they are also hard, and have all the fineness of grain and homogenousness of texture which are necessary.

On Polishing the Stones.—Polishing is an operation by means of which a uniform and flat surface, and a polish more or less high is given to the stone, according to the different kind of design or of work for which it is intended. The care and precision with which this first preparation of of the stone is effected, are not of less importance to the execution of the design than to that of the impression. A stone, the grain of which is unsuitable for the crayon, will not allow the artist to regulate his tints and to give them harmony; when he works in ink, or with the dry point, he will meet with other obstacles if the polish of the stone be not perfect; and in each case his drawings will be defective; but they will be more so, if in the surface of the stone there are undulations, hollows, stripes, &c.

Stones are polished with sand, by rubbing them one on the other. The best sand for this purpose is that quartzose sand which is fine and hard grained. In Paris they in general make use of a yellow sand, which, though fine, requires to be sifted. It is necessary to be very careful that the sand which is used be not mixed with gravel or any sharp angular substance which would form stripes on the stone, the hollows of which would not receive the printing ink, and there would consequently be white marks on the impressions. This serious evil is avoided by sifting the sand before it is used, and by rubbing the upper stone slowly at the commencement of the operation, and occasionally turning it round upon the lower stone.

The kind of design for which a stone is intended determines the kind of polish which should be given to it. A work in which the crayon is used cannot be executed unless the stone have a grain left upon it; all other kinds of drawing require surfaces which have the polish of marble. Whether we wish to employ a fresh stone, or to renew one which has been already used, it must equally undergo the process of polishing. For this purpose it is placed on a table in the manner to be hereafter described; a little sand is very equally sifted over it, which is moistened with a very little water. On the first stone is placed a second, as nearly as possible of the same dimensions, and the upper one is rubbed about in a direction nearly circular, but drawing it successively towards the four corners, and continually changing the relative position of the stones, so that every part of their surfaces may be subjected to an equal degree of friction. If this be neglected, and the stones be pressed on each other, and the circular motion be always the same, hollows will be formed and uneven surfaces produced; and these irregularities will show themselves in the impressions. It is easy to ascertain, by means of a straight line, whether the stone be well levelled.

At first the motion should be slow and the pressure trifling, the rapidity of the one and the force of the other increasing as the sand becomes equally distributed. When the sand becomes reduced to a paste it no longer acts upon the stone; fresh sand must be taken until the stone be perfectly smooth, and there no longer remain on it the traces of any former design. The ink which formed this design may have been made to disappear without our having removed the source of its reproduction. This cause exists in the particles of the fatty substance of the crayon, or of the ink, which have penetrated below the surface of the stone, and which being again brought in contact with the printing ink, will retain it, and reproduce part of the old design. It may be known that this cause exists, when it is perceived that in the *wet* stone there are light traces of the former drawing. It is then necessary to continue the rubbing until these have entirely disappeared. The aquafortis employed in the preparation of the stone for printing will, by itself, produce this effect when the traces are very superficial. It should be remarked, that of two stones of the same size, the lower becomes polished sooner than the upper one. To avoid this it is only necessary to change their position.

In order to produce on a stone intended for a drawing on crayon, the grain which it ought to have, it is necessary, after having treated it as we have just described, to sprinkle and rub it again with fine sand, which, by the friction which it produces, may be made to give the desired grain. When it is wished to obtain a coarse grain, the stone is rubbed for a less space of time with the sand, this being also renewed more frequently; but the rubbing with the same sand is prolonged when a very fine surface is required. This rubbing, however, should not be continued too long, or the grain which has been produced will be destroyed. The state of the grain may be judged of by blowing briskly on the surface of the stone, on which has been placed a little water, and then examining its plane by looking at it in an oblique direction.

When stones intended for drawings in ink, or with other materials fit for lithography, are to have a very high polish given to them, the procedure is the same as that we have just described, excepting only, that after having produced a fine grain on the surface, the rubbing is continued with the same sand reduced to a thin paste, taking care to wet the stones when the adhesion between them becomes so great as to prevent them moving freely. The workman, when he discontinues his labour, should not leave the stones in this state, as they would adhere, and could then be separated only by keeping them in a vessel full of water.

The stones having acquired, by the operation described, a certain degree of polish, are well washed, in order to remove the grains of sand, which might produce scratches; a fine polish is then to be given to them by means of pumice-stone. This polishing is effected on one stone at a time, by rubbing it with a large piece of pumice-stone after it has been slightly moistened. The rubbing should be in a straight line, sometimes in one direction and sometimes in the opposite, passing successively over all parts of the surface of the stone. By thus rubbing with the pumice-stone and the white paste which it produces, only adding water enough to preserve a slight degree of moisture, the beautiful polish of marble is produced. It is afterwards necessary to wash the stone in a considerable quantity of water, rubbing it with the hand, or with a cloth entirely free from grease, and thus to remove any particles of matter which, by their position on the surface of the stone, would present a substance intermediate between that surface and the drawing, which would prevent the adhesion of the latter.

Three kinds of grain may be given to stones, the coarse, the middling, and the fine. The first produces designs, the proofs of which have not the finish and delicacy of those which are obtained on the two others. The second ought in every case to be preferred, for it possesses all the properties requisite for beauty of execution, although the proofs which it produces have not an appearance quite so soft and mellow as those from stones with the finest grain. But these last have the great disadvantage of soon losing the delicacy of the design, of clogging readily, and consequently of affording much fewer proofs. In every case it is necessary that the grain should be smooth and uniform over the whole surface of the stone, otherwise the lines traced by the crayon will be found nearer to each other, or more strongly marked in some places than in others; the proofs, in reproducing the same defects, will be found without harmony and without effect.

When it is intended to execute very beautiful designs, it is necessary to reject the stones which are too soft; those which have hollows; those whose texture is softer in particular spots than in the general mass; those which are not of equal thickness, and which have inequalities in their upper surfaces; those, in short, which are not of a good quality and well polished.

A last precaution is, to preserve the grained or polished stones under cover, to protect them from the air and the dust, and not to touch them with the hand, or any greasy substance, on that side which is to be worked upon. They are preserved by wrapping them up carefully in an envelope of white paper.

(*To be continued.*)

LXXIV.—*On a new Steam and Heated Air Engine, or Economical Methods of using Heated Air, Gases, Elastic Fluids, and Products of Combustion, which are available to the increase of Steam Power. By Mr.* MINUS WARD, *Civil Engineer, Baltimore, U.S.*[*]

THESE methods consist in employing, or using, in whole or in part, the air which is heated while passing through the fire of the furnace attached to the steam-engine, together with the heated gases, elastic fluids, or products, set at liberty, or given out by the burning fuel in the same. By means of sundry appliances and machinery, which are added or affixed to the steam-engine, to *force* or *throw into* the boiler, either below or above the surface of the water in the same, the aforesaid heated elastic fluids, or products of combustion, thereby causing them to mix or unite with the steam; thus availing myself of the caloric and agents, which are ordinarily suffered to escape through the flue or chimney into the atmosphere, and are lost. This may be put in practice by an indefinate variety of methods.

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[*] From the *Franklin Journal.* Mr. Ward has obtained patents for his invention; the above is an extract from his specification.

One method is, to place a pneumatic forcing-pump, which we will call the *gas-pump,* on the top of the boiler of the steam-engine; a pipe, or tube, extends up from the surface below, through the water and steam in the boiler, and enters the bottom of the gas-pump chamber, where there is a valve opening upwards. By the side of this valve there is another valve opening downwards, into the cavity of the boiler. The piston of the gas-pump is driven by the engine. From the upper part of the boiler, commonly called the steam-chamber, a pipe extends to the steam, or working cylinder of the engine, which cylinder is of a construction no way different from that of the steam-engine in common use.

Operation.—As the piston of the gas-pump rises, the valve, which opens upwards, will be forced open by the laws of atmospheric pressure, causing the heated elastic fluids and products of combustion to follow the piston. The other valve being kept closed by the pressure of the steam in the boiler, the heated air, gases, and other heated products of combustion, rise from the burning fuel in the furnace, and passing up through the pipe and the valve, fill the chambers of the gas-pump, the cubic contents of which may be, to those of the steam, or working cylinder, as 169 to 256, or theaeabout. On the descent of the piston, the inlet valve closes, and as soon as the descent of the piston, by compressing the heated air, gases, and other heated products of combustion in it, causes their elastic force to become greater than the elastic force of the steam in the boiler, the valve in the boiler opens, and the contents of the gas-pump are driven into the boiler, at a temperature nearly equal to what it was in the furnace; where, coming to an actual contact, and mixing with the steam, they give out a portion of their caloric to the steam, and the temperature of the mixture will be higher than that of the steam was before the injection of the said gases. The increased temperature will cause a corresponding increase of the elastic force; the mixture of steam and other heated elastic fluids, thus formed, passes on to the working cylinder of the engine, where, after acting by their pressure upon the piston of that cylinder, they are either suffered to escape into the atmosphere, or they are conveyed to a condenser, where the steam and aqueous parts of the mixture are condensed, in the same manner as steam in condensing engines. The water thus formed, the injecting water, with the air, gases, &c., are pumped out together. The above arrangement of parts has been specified, on account of the ease with which it may be understood.

Another modification is, to immerse the gas-pump in the boiler, with its upper flange upon the top of the boiler. A tube, open at both ends, extends from near the upper part of the steam-chamber internally, down along the side of the gas-pump, and enters the bottom of the same. By this arrangement, as the piston of the gas-pump rises, the chamber below the piston will be filled with steam; and as no valves are placed in this tube, on the ascent of the piston, this steam will be returned into the steam-chamber; the use of this is, to keep the packing of the gas-pump continually damp, so as to prevent it from being burned. The inlet and outlet valves are placed upon the top of the pump, the piston-rod working through a stuffing-box; a tube extends from the furnace to the inlet valve, and another tube extends from the outlet valve to the steam-chamber. The gas-pump may be also placed externally on the end or side of the boiler, and be a double acting pump, with a pair of valves, as above described, at each end thereof. In this plan, an elastic metallic piston may be adopted; one method of making which, is to substitute for the packing of hemp a packing or gasket of card-wire, which is applied in the same manner as the packing of hemp.

In the above methods, if it be intended to take into the gas-pump a larger part, or the whole of the heated elastic fluids, and products of combustion, a damper, or valve, may be placed in the flue or chimney, above the tube leading to the gas-pump; which damper, after the engine is in operation, may be totally or partially closed. If it be entirely closed, the draught and the consumption of the fuel in the furnace will be in proportion to the capacity of the gas-pump, and the number of strokes made by its piston in a given time.

LXXV.—*On the employment of the Anthracite, or Stone-coal, in the United States.* *By* WILLIAM MEADE, M. D. *&c.**

WHEN the anthracite of Rhode Island is in a state of strong ignition, a very remarkable circumstance may be observed, which is strongly characteristic of it, and which distinguishes it from bituminous coal. The anthracite burns away slowly; no part of it is either consumed or altered, except the surface, which is exposed to the flame; and if a large piece, which has been in the fire for some hours, is taken out, and either plunged into cold water, or let extinguish itself, it will be found to have lost considerably in size and weight, and its surface will be charred; but if this piece be broken with a hammer, the interior appearance of the coal is not in the smallest degree altered from its original state, but preserves the same steel gray, or metallic lustre, thus consuming away gradually in the flame, like the diamond when ignited in oxygen gas.

Though it is many years since I first paid attention to the subject of the Rhode Island coal, and was the first person who called the attention of the public to the great advantages they would derive from an extensive use of it in the arts, yet I have a perfect recollection of the difficulties we laboured under in order to persuade many, whose interest it was, to give it a fair trial. The first impression which it was difficult to get over was, that it never could be ignited; and when they were at last convinced that this was erroneous, the next objection they started, was, that the heat was so intense that it was impossible either to regulate or check it. The blacksmith complained that he no sooner put an iron rod into the fire, for the purpose of making nails, than the rod was completely melted; as soon, however, as a little experience taught them the management of the fire, they preferred this coal to any other.

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* Extracted from his letter to Professor Silliman, in the *American Journal of Science and Arts*, March, 1827.

As soon as I ascertained, by experiment, that the Rhode island coal contained at least 90 per cent. of pure carbon, it naturally occurred to me, that it might be made use of with advantage in furnaces for the smelting of iron ore, in the same manner that coke is in England, it being perfectly obvious that this coal, in its natural state, had all the essential qualities of coke, without either the trouble, waste, and expense, which is necessary for converting bituminous coal into coke, before any use can be made of it by the iron manufacturers. It is scarcely necessary to state here, that the universal application of pig-iron in almost any shape to the purposes of manufactures, and even the necessaries of life, may be traced entirely to the present improved state of the fabrication of pig-iron with coke, or the char of pit coal. In order to determine this question, I accompanied one of the proprietors of the coal mine to Kingston, in Massachusetts, where several furnaces were at work in smelting bog iron ore. After some persuasion, and not without a *douceur* to the workmen, in order to reconcile them to the experiment, we proceeded to charge the furnace with alternate layers of ore, charcoal, and Rhode Island coal, broken into small pieces; and in order to see that the experiment was fairly tried, I never left the furnace for twenty-four hours. The process went on as usual, the common blast being sufficient to keep up the requisite heat, and on tapping the furnace it was found that a much greater quantity of metal flowed from it, than was usually produced by the use of charcoal alone, and that it was also of a better quality: it was also ascertained that the furnace required to be tapped much oftener than before. This satisfied every person concerned; but as the place was at a very inconvenient distance from the coal mine, it did not turn out so advantageous to them as it otherwise would.

I am not aware that any fair experiments have been yet made by the iron manufacturers, to introduce the use of this or the Pennsylvania coal into their blast furnaces. I have often heard it asserted that it did not or would not succeed, but no sufficient explanation of its failure has ever been given. Of all the uses to which coal of this kind can be applied, that of manufacturing iron from the ore is the most important. A person who is in any degree acquainted with the true principle of reducing ores to the metallic state, will require something more than the bare assertion to convince him, that coal which has been proved to contain more than 94 per cent. of pure carbon, is not adapted to the smelting of iron ore. It has been asserted that it would not bear the blast of a bellows; but so far from this being the fact, I am willing to assert, from experience, that it bears the blast better than charcoal, and that this is one of its essential qualities; as, by this means, while the lighter kinds of charcoal are dissipated by the blast, without being allowed to come in contact with the ore, this coal, not being driven off by the wind of the bellows, remains longer in a state of ignition in contact with the ore; thus producing much more metal from a given quantity of it, than can be obtained from charcoal alone. It would be uncandid in me not to state that, in the experiment which I witnessed at the Kingston furnace, it was observed that small pieces of coal ran out at the opening from whence the metal was drawn, flowing on the surface of the slag or scoria; but this is easily explained, by referring to the statement which I have given of the chemical properties of the coal, which only consumes on the surface exposed to ignition in oxygen. The largest pieces, therefore, remaining in contact with the metal, were only partly consumed, and falling down with it to the bottom of the furnace, flowed out with the slag, without being entirely consumed in the processs. This, however, only showed that the coal was not broke small enough, and admits of an easy remedy. The same circumstance occurs sometimes when charcoal is used, and those who examine the scoria after a blast, will frequently perceive in it particles of charcoal unconsumed, which have intermixed with it, and flowed out of the furnace in that state. Let me, therefore, urge on the iron manufacturers to abandon their prejudices, and to turn their attention to the expediency of the use of this fossil coal, so abundant in this country, and so favourably situated for that purpose. Without doing so, iron mines may be discovered without advantage, and canals constructed in vain.

While the coal fields at Rhode Island were extensively worked, an immense quantity of small coal had accumulated in the neighbourhood of this mine which was unfit for the market, and was therefore considered as useless; it ought not, however, to have escaped notice, that this small coal was adapted to many useful purposes, being very similar to what is called culm in England and Wales, which is generally and extensively used in the burning of lime and bricks. One of the most favourable situations that could be wished, for the extensive use of this small coal in the burning of lime, occurs within a short distance from the mines, and with the advantage of water carriage; I refer to the valuable quarries of the finest lime-stone which is made use of principally for the manufacture of lime. Here, and at Smithfield, there are so many kilns in operation, and for so many years the consumption of fuel has been so great, that there is scarcely a tree left in the neighbourhood, and fuel has risen to such a price as will soon render this once lucrative business an unproductive one, though with so many advantages of an inexhaustible supply of the purest limestone, and convenient water carriage. A proposal was therefore made to the proprietors of those works, to substitute the small coal instead of wood, for the use of the kilns, offering to supply them at a very low rate with any quantity of it: only one, however, could be prevailed on to make a trial of it, which he did in his own way, and when the operation, as he thought, was finished, he found that the greater part of the contents was vitrified, or converted into a slag, which adhered so firmly to the sides of the kiln, that it could be removed only by crow bars. At first he could not be persuaded that it would produce sufficient heat, and therefore was careless about the quantity. The consequence was, as may naturally have been expected, that the heat produced was so intense as to vitrify the greater part of the limestone, which adhered to the sides of the kiln. Such an obvious effect, however, which would never have occurred had the coal been applied in proper proportions, so far from satisfying the owner with the certainty of success, only prevented him from making a second attempt.

Much such another circumstance as the above, occurred in the neighbourhood of Boston, where there are extensive brick kilns, but where, also, there exists a great scarcity of wood for fuel. It was not without difficulty, however, that one of the proprietors consented to make trial of the Rhode Island coal. The process of burning went on as usual; but when the operation was supposed to be completed, and they came to examine the result, it was found that the surface of the bricks was completely vitrified, and that they adhered to each other in one solid mass, to the great disappointment of the owner. It was impossible, however, not to see and be convinced, from this experiment, that the failure arose, not from any defect in the coal, but from the excessive and intense heat, produced either by too great a quantity being used, or by keeping up the fire longer than was necessary; and thus an experiment which completely proved the applicability of this coal to so valuable a purpose, tended only to convince the ignorant workmen that the failure arose from the unfitness of the coal for any such purpose. Let me now be permitted to ask such persons, how it happens that English bricks are considered so superior to American bricks, that large quantities are still imported, and command a higher price in the market? To this I will answer, because they are better burnt than the American bricks; and this arises from the use of *culm,* a very inferior kind of coal to that which is rejected in this country.

In the essay, which I published several years ago, on the application of Rhode Island coal to the arts and manufactures of this country, I pointed it out as peculiarly calculated for producing that equable and steady heat which is required for the rolling and slitting of sheet-iron. This has now become an article of prime necessity in this country, and I am prepared to say that no fuel whatever is so well adapted for the purpose. The sheet-iron is heated to the necessary degree for the roller, in half the time that it can be done by any other fuel; and a manufacturer assurred me that the surface of the iron, heated in this manner, was not only much cleaner, but that the iron lost much less of its weight by this process than by any other.

It is extremely singular, that the public should have been so long prejudiced against the use of the Rhode Island coal, as well as of every species of anthracite, in any way, or for any purpose whatever. I early perceived this prejudice, but foresaw that a period would arrive when its real merits would be appreciated. Indeed, I never had any doubt but its true value would be discovered by the artists; but I did not expect that the time would so soon arrive when it would be so generally introduced into domestic use; nor am I now prepared to say that I prefer it to bituminous coal, when used in common grates; not that it will not burn in grates, as is fully experienced in Philadelphia, but because it differs so essentially from bituminous coal in the liveliness of the flame, and the quickness with which it can be ignited. Where a uniform temperature is required to be kept up in all parts of a house, there is no mode whatever of accomplishing it equal to the use of the anthracite, in those stoves or furnaces which are now so ingeniously and judiciously constructed in Philadelphia. I think that it is quite a mistake to imagine that a great draft of air is required to keep up the ignition of the fire with this coal; and I am the more convinced of this, from having seen the manner in which the same kind of coal is burnt in the county of Kilkenny, where no other fuel is used. There the grates are precisely the same as those used in England; all that is required is *patience*, and that the fire should have sufficient time to kindle. No coal whatever answers the purpose of cooking better; but I always observed, in Kilkenny, that the kitchen fire was made the night before, in order to have it in a state of perfect ignition the next morning. Indeed, I was perfectly satisfied of this, from experience at Rhode Island, where I have frequently seen the Irish workmen, in cold weather, sitting round large fires, placed on iron bars, in the open air; and, in one instance, I observed a large fire, made in the open air, in an old iron pot which had a hole in the bottom; one of those contrivances the result of accident and necessity.

I cannot take leave of this subject, without expressing some surprise that so little pains has been taken to ascertain whether the anthracites of this country may not be applied to the use of the steam-engine. Let us consider how little benefit the English would have derived from the discovery of the steam-engine, if it were not for the inexhaustible supply of coals which are afforded from their mines. That the woods of their country are not inexhaustible, may be easily evinced by the great scarcity of timber in the neighbourhood of populous cities, and the consequent difficulty of obtaining wood at a reasonable price, for the use of the numerous steam-boats now navigating their rivers. Those difficulties will increase so as to be a material obstacle to their use. It is a common opinion, that there can be no other mode of heating the boilers, but by the reverberatory furnace now in use. I am well aware that the anthracite or non-bituminous coal of this country is not well if at all calculated for a reverberatory furnace; but I am also convinced that a boiler may be so constructed as to be heated with equal facility, if not greater, by the use of this coal, than by the use of wood, which has so many inconveniences attending it, particularly in steam-boats; and I am sure no person will presume to contest this, when informed that a large steam-engine was kept in constant operation, at the mines in Rhode Island, with the use of no other fuel than the coal on the spot. If this fact is not convincing, I know not to what other to appeal. It is not difficult to foresee that the period will soon arrive when the obstacles which impede the use of this coal in the steam-engine will be removed. That a boiler may be so constructed as will answer the purpose of generating a sufficient quantity of steam, with a very limited proportion of fuel, has been already exemplified by the ingenuity of Mr. Perkins, who, as if with an eye to this subject, has invented a generator peculiarly calculated for the use of this coal, and which, if successful, will totally explode the use of wood, and remove many of the objections to the use of steam-engines for the purposes of navigation. Greater prejudices existed here, at one time, against the use of this coal in any form, and for the most obvious purposes; these are now happily dissipated by the light of reason and experience.

LXXVI.—*On washing over Emery for Optical purposes, &c.* *By* M. Chezy.

In order to obtain *very fine emery*, and of different degrees of fineness, the sieve is not sufficient, but water must be used. After having well ground the coarse emery on an iron plate, with a muller of the same metal, it is thrown into a vessel, which must be rather wider at bottom than at top, by a gradual increase. The vessel must then be filled with clear water, so that it may stand eight or ten inches above the emery. The whole is then to be strongly agitated with an iron spatula; after which it must be left to settle for an hour. The emery falls to the bottom, but the water remains turbid, being charged with emery, in the state of an extremely fine and light matter. Into this water must be plunged the shortest branch of a syphon, filled with clear water, to the depth of four inches below the surface of the water, holding the other extremity of the syphon closed with the finger, which is afterwards withdrawn, that the water may flow through the syphon, without stirring the vessel, or agitating the emery which is at the bottom of it. The water thus drawn off is to be received into another large vessel, and the first vessel is to be again filled, and its contents agitated as before. The same operation is to be repeated till the water passes clear through the syphon. The powder which has passed over with the water, and was received in the second vessel, is too fine to be usefully employed in grinding glass. The vessel being emptied and cleared, the same operations are to be repeated, with this difference only, that instead of leaving the water to settle for an hour, no longer time is employed than half an hour; and when the water passes clear through the syphon, the operation is discontinued; and the emery obtained by subsidence from the water, and carefully defended from all impurities, is reserved under the denomination of "*emery of half an hour.*"

The same operation being repeated, allowing only a quarter of an hour for the subsidence, affords an emery which is indeed fine, but less so than the preceding, and is to be reserved under the denomination of "*emery of a quarter of an hour.*"

By similar processes, emery may be obtained of half a quarter of an hour, of four, of two, of one, of one half, or one quarter of a minute. To measure the half or quarter of a minute, a pendulum beating seconds (or a weight suspended by a string of 39,2 English inches) may be used. The oscillations are to be counted from the moment of the ceasing of the agitation; and, at the instant of the thirtieth or fifteenth oscillation, the finger being withdrawn from the mouth of the syphon, previously placed in the water, suffers the water to flow. The sieve may be used for coarser emery.

Observations by the EDITOR.

We have extracted this article from Nicholson's quarto journal of Natural Philosophy, vol. III. It forms a useful addition to the information we gave in vol. II. of the *Technical Repository*, on Mr. Blore's (a late workman of Mr. Tulley's) method of washing over emery. We do not think, however, that the finest emery would be of no use in grinding glass; on the contrary, we have found that the glass *greyed* by *the finest emery we could produce*, and applied upon lead, is the best to be employed in the microscope, for removing the false glare produced by the sun's light, or the light of a candle or lamp.

It would be convenient to mount the syphon in a hole made in a piece of flat wood, at the proper height, to reach four inches down below the surface of the water, when the wooden board was laid upon the top of the vessel, and thus save the trouble of supporting it at the proper height by the hand.

LXXVII.—*On Casting, Grinding, and Polishing Speculums, for Reflecting Telescopes, Microscopes, &c.* *By the Rev.* John Edwards, B.A.[*]

On the best Composition for Reflecting Specula.—I found that thirty-two ounces of copper, with fifteen or sixteen ounces of grain tin (according to the purity of the copper), with the addition of a little brass and arsenic, viz.—one ounce of each to the above proportion of copper and tin will form a metal capable, when polished in a proper manner, of reflecting much more light than any other metal that has yet been offered to the public. When I say that the proportion of tin is from fifteen or sixteen to thirty-two ounces of copper, I would be understood that the proportion of tin will not always be accurately the same, as copper will take more or less tin to saturate it according to its purity. It might be of use previously to purify the copper as much as possible[†]. A very little experience in these matters will enable any one to know when the copper is completely saturated, as the composition will, if broken, appear of a most beautiful bright and glossy nature, very much resembling the fine face of quicksilver. My method to ascertain that point accurately is to melt thirty-two ounces of copper, and to add to it, when sufficiently fused, fifteen ounces of tin, and to pour the mixture into an ingot mould; then, to a certain known portion of this composition, I add a very small but known portion of tin; and thus, by a few trials, I can easily obtain the point of complete saturation, and the maximum of perfection. Having then ascertained what portion of tin I added to the above known quantity of the composition, I add the proportional quantity of tin to the whole when melted a second time. Thus, if I find that I must add a quarter of an ounce of tin to one pound of the composition, so as to obtain the *ne plus ultra* of brilliancy*, then I know that when I shall melt the remainder of the metal a second time, in order to cast the speculum, I must add one of grain tin to four pounds of the composition, made according to the proportion of thirty-two ounces of copper to fifteen ounces of tin. The arsensic must be added in the second melting, when the speculum is intended to be cast†, as the heat of the mixture in the first melting is so great as to render the most part of the arsenic volatile, and in a great measure prevent its action upon the metals. It is somewhat singular that arsenic, though particularly recommended by Sir Isaac Newton for this purpose, should be hastily thrown aside by the founders, as well as passed over unnoticed by the writers upon this subject. This imprudent disuse I can only attribute to the disagreeable fumes or vapours which arise when it is introduced into the crucible to the melted mixture, which may produce disagreeable effects upon the operator, if proper care is not taken to prevent them from being received into the lungs. All the precaution necessary is to bruise the arsenic coarsely, and introduce it into the crucible with a pair of tongs, having tied it up in a piece of paper; give it then a stir with a wooden spatula, retaining your breath; avoid it till you can see no more vapours arise from the crucible, when the metal will be ready to be poured into the flasks to cast the speculum. The great use of arsenic in this composition is to render the metal much more compact and solid, and indeed much more beautiful, as one may experience by comparing the composition with arsenic with the same composition of copper and tin without arsenic. In general I find one ounce of arsenic sufficient for one pound of the metal. A much greater quantity of arsenic may be used without any disadvantage to the beauty or compactness of the metal, but then it is too apt to tarnish if exposed to the air for some time; three quarters of an ounce, or an ounce of arsenic, to one pound of composition will not tarnish in the least degree. Indeed, the reason why the metals generally made use of for specula tarnish, when they are much exposed to the air, is because the quantity of copper in their composition is not nearly saturated, and the oxygen contained in the air, by acting upon it, extracts the copper from the tin, and turns the metal into a dirty or dingy-coloured speculum; and which (besides the loss of light) causes the common reflecting telescopes to show all objects of a dirty red, or yellowish colour. This, however, is not the case in the metals made of the above composition; for as the copper is completely saturated, the air cannot act upon it in the least degree. I must not, however, pass over one caution in the mode or manner of melting the composition, and that is, that the copper must be melted first of all, and rendered as fluid as possible; then the brass and silver (if any is employed) must be added, and the whole fluxed with the common black flux, made of two parts of tartar to one of nitre, or by stirring the melted mixture with a wooden spatula of birch, and made as fluid as possible. The tin must now be added, and the whole poured off immediately, after it is once stirred together; for if the mixture is continued on the fire some time after the tin is added to it, it will prove porous afterwards, though it be melted another time with the smallest heat possible. As I ever found this to be the case, I naturally conjectured that the metal would be most solid and free from pores when the tin remained the least time possible in a state of calcination. Experience determined the truth of my conjecture, and I now find that the best method possible to make this composition to the greatest advantage, is to melt the copper as fluid as possible, and flux it with the black flux; to melt the tin in a separate crucible by itself; to take the two crucibles out of the fire, and pour the melted tin into the copper; and stir it instantly with a wooden spatula, and pour the whole immediately into a large quantity of cold water. The sudden chill from the cold water divides the melted mass into an infinite number of small particles; and by that means cools it instantaneously, and consequently prevents the tin from calcining sensibly; and hence I have always found, that in the second melting the composition was entirely free from pores, even although no arsenic had been employed: yet the addition of arsenic ever rendered it more compact, and indeed specifically heavier*, as well as more brilliant and beautiful. On reversing the process, if the tin is put into the bottom of the crucible, and the copper at the top of it, which I have frequently done, the copper will melt with a very little heat; whereas, when copper is put into the crucible by itself, it requires a pretty strong heat to cause it to melt. When I first made use of this method, I imagined I had discovered a very easy one to melt the copper, and consequently I thought I had greatly improved the common method; and as Mr. Mudge ascribed the pores in the metal to the tin being calcined by the great heat of the fluid copper at its first melting, I naturally expected to find the metal, made by the above process, totally free from pores, especially in the second melting, as the heat was considerably less than if the copper had been melted first by itself: however, I always found it full of pores, much more porous than I had ever seen it before. For some time I could not discover the true cause, having no idea that the pores were owing to the tin remaining so long in the fire in a fluid state, and therefore in a state of perpetual calcination. I attributed the porosity of the metals which I made of this composition to a multitude of causes, till, thoroughly tired of experiments and conjectures to ascertain the true reason, I was determined to melt the copper first, and the tin afterwards, as I had always done, before I dropped upon this improved method, as I imagined. The result was, the metal was infinitely more compact and much less porous. By melting the copper first, and then adding the tin to it, I soon discovered that the longer the tin remained in the fire, the more porous the metal turned out; and, *vice versa*, the sooner I poured it off, after I had added the tin, the more compact and free from pores it proved. From these observations I determined to try the effect of adding the tin in a fluid state to the melted copper, and to cool the whole immediately, to prevent, as far as I was able, calcination from taking place. Experience confirmed my conjectures, and I soon found that by pouring the whole melted mass the instant they were mixed and stirred together into cold water, the metal always proved in the second melting solid, and much more compact, beautiful, and white, than I had ever before seen it by any other process*. One thing I cannot pass over, as it affords a clear proof of the use of arsenic in rendering the metal much more solid and compact, and consequently more free from pores than if no arsenic had been used in the composition. Whenever I made the composition by melting the copper and tin together, the metal was always porous as I observed before; however frequently I melted it afterwards, and though I gave it no more heat than was barely necessary to melt it, yet if I added to this very porous metal, after it was melted, a small quantity of arsenic, viz.—one ounce to one pound of the metal, it was really astonishing to see how much better the metal turned out, being considerably harder than before, and incomparably less porous. I mention this circumstance, which any one may easily try, to

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[*] Extracted from the Nautical Almanac for 1787. This subject becomes interesting from the present application of speculums to the Amician microscopes.

[†] Or to remove all remains of oxygen from it.—Editor.

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* If too much tin should be added, viz.—if seventeen ounces of tin is put to thirty-two ounces of copper, the composition is not brilliant when broken, but of a grey blue and dull colour. If the quantity of tin be further increased, the metal will be almost black.

† Sir Isaac Newton melted the copper first, then added the arsenic, and lastly the tin; as, without doubt, he knew that the tin should remain in a fluid state the shortest time possible. It is true that he added the arsenic to the melted copper, but as he well knew that a great part of it would be rendered volatile, he therefore added a very large quantity of it, viz.—arsenic one, to copper six.

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* The specific gravity of the composition itself is 8,78, with the addition of one ounce of arsenic to one pound of metal, 8,89.

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* These judicious observations, so ably expressed, ought to be always attended to, when we wish to make other alloys of metals as perfect as possible.—EDITOR.

show the very great advantage of using a small portion of arsenic to render it more compact, and, as Sir Isaac Newton justly observes, more white than before*. The use of the small portion of brass in this composition is to render it more tough, and not so excessively brittle, as this composition without the brass would prove. A small portion of silver will make the metal much whiter, though if too much is added it is apt to be porous. Having said so much relative to the composition of the metal, which indeed is a capital article, I pass on to

The Manner of Casting the Metal.—The sand most proper for casting this, and indeed any other metal, is a fine sand with no more loam or clay mixed with it naturally than is sufficient to make it tenacious enough to adhere together, when properly moistened. If too much clay is mixed by nature with the sand it will always blow the metal in different directions; sometimes, indeed, to the great danger of the operator. On the contrary, if the sand does not contain a sufficient quantity of clay it will not remain in the flasks, and take a proper impression from the pattern or model. The best sand I could ever meet with, for the purpose of casting specula, is the Highgate loam (near London), generally used by the London founders. It should be as little wet as may be, and well beaten, but not too hard. The flasks should be at least two inches wider than the metal intended to be cast. If the sand is not of a sufficient thickness round the metal it will instantly become dry when the hot fluid metal, is poured into it, and consequently will contract, and of course the fluid metal will run out of the flasks. A proper thickness of sand will, however, prevent this accident. The metal or pattern should be made of brass or hard pewter, and must be a little larger and thicker than the speculum intended to be cast from it, as the thing cast is always a little less than the pattern, owing to its contracting a small degree in cooling. A wooden pattern will not quit chief reason why workmen do not give a good figure to their specula is, because by pursuing Dr. Smith's or Mr. Mudge's methods they use too many tools, which, in a great measure, destroy each others effects. As nature always acts in the most simple manner, so if we could always imitate her in this respect, we should arrive at a much greater degree of excellence in most of our mechanical pursuits. Besides, the tools generally made use of by workmen are considerably too large in diameter ever to give a direct and uniform figure. All the tools I make use of are a rough-grinder, composed of lead and tin mixed together, or else of pewter; this rough-grinder serves also for a polisher; this tool, with a bed of stones. or hones, are all that are necessary. A bruiser (as directed by Dr. Smith and Mr. Mudge) is totally unnecessary, causes considerably more work, and after all is really detrimental. The best method I have ever found to rough-grind the speculum, is to grind the surface of it quite bright, upon a common grindstone made nearly to the figure or focus of the speculum by a gauge*. Take it then to a convex tool made of lead and tin, or else of pewter, and grind the metal upon it with fine emery. This emery, however fine it may be, will break up the metal very much; but we can easily cure that process, as I shall show hereafter. This tool, or rough-grinder, should be made of an elliptical form, and not circular (for a reason which I shall point out hereafter), and of such dimensions, that the shortest diameter of the ellipse shall be equal in breadth to the diameter of the mirror; and the longest diameter of the elliptical tool should be to the shortest diameter in the proportion of ten to nine, accurately, for a reason likewise to be mentioned hereafter.

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* See Appendix to Gregory's Optics, p. 219; or the Philosophical Transactions, No. LXXXI.

(To be continued.)

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* The grindstone may be easily brought to the form of the gauge, by holding the sharp end of an iron bar against it while it is turned round, till so much is worn away from its surface as shall cause it to take the true curvature of the gauge.

e done with as small a degree of heat as pos-
roportional quantity of crude arsenic in
stir it with a wooden spatula; when
take the metal off the fire, take
dd half an ounce of powdered resin,
of resin and nitre, in order to give the
e; stir it well with a stick, and pour it
o the flasks. When the git is filled up with
d strike the flasks gently, so as to shake or
al in them in a small degree; this will prevent
in the face from any air-bubbles being lodged
When the metal has remained in the flasks a few
es, so as to become entirely solid, open the flasks
e the metal is red-hot (it cannot crack in this state
ough it is exposed to the air, as all metals are malleable when they are red-hot), and take out the speculum with a pair of tongs, laying hold of it by the git, but take care to keep the face downwards to prevent it from sinking. Force out the sand from the hole in the middle of the mirror with a piece of wood or iron, and place the speculum in an iron pot, with a large quantity of hot ashes, or small coals, so as to bury the speculum in them a sufficient depth. If the sand is not forced out of the hole in the manner above directed, the metal, by sinking as it cools, will embrace the sand in the middle of the speculum so tight, as to cause it to crack before it becomes entirely cold. And if the metal is not taken out of the sand and put in a pot with hot ashes or coals to anneal it, I can assert that the moisture from the sand will always break the metal. Let the speculum remain in the ashes till the whole is become quite cold. The git may be easily taken off by marking it round with a common fine half-round file, and giving it then a gentle blow. The metal is then to be rough-ground and figured.

The Rough-Grinding and Figuring the Speculum.—In rough-grinding, figuring, and polishing the metal, two tools only are necessary, besides a common grindstone. One tion? This I found took place in my cylinders, when the engine was not at work, after I had discovered that I could dispense with the use of oil. If it is not new to dispense with the eduction-valve and eduction-pipe, having no other than a small induction valve, and that so constructed, as to neutralize the pressure, requiring no oil, and very little power to open and close it? If it is not new to allow the steam to escape at an opening 250 times larger than the steam-pipe? All these have been effected, as our friend Lukens can avouch, he having witnessed all the facts as well as myself. And, lastly, if it is not new to have discovered that steam may be generated, although in contact with water, at all temperatures, without producing corresponding elasticity?

As soon as my last patent is specified here I will forward it to you, together with the drawings, not only for your inspection, but with a request that you will forward them to Washington, as a petition to obtain a patent will accompany them.

I herewith send you a paper "On the Explosion of Steam Boilers, &c.*" This paper I have not yet published here, as it might lead to the discovery of my method of correcting the evil arising from generating surcharged steam before my patent is specified; but as this will be secure in a very short time, you are requested, if you approve it, to publish the paper in your interesting journal, as I am anxious for its early appearance in my own country. I have, in confidence, given a copy to Dr. Wollaston, to Mr. Faraday, and to several engineers whom I could trust, and who all agree that it assigns the true cause of all those explosions. I long to see and to converse with you and my other really scientific friends in the United States, on this and other interesting points connected with my engine.

I have had much interested opposition to contend with since my residence here; but some of the best men in the country have constantly befriended me, or I must have sunk under the pressure.

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* Published in Vol. XI. of the *Technical Repository*, p. 294.

More than a dozen projectors have attempted to make tubular boilers since I commenced my experiments of generating steam from small quantities of water under pressure; but for want of pressure (which is the novelty I claim in my patent) they have all failed.

I am now engaged in building steam artillery as well as musketry for the French government. The English government would certainly have adopted this invention had it not been for the statements of certain engineers, who declared, that although I was able to make a great display at the public exhibition, made by order of government, yet it was delusive; that I never made a generator which stood for a week; and that I could not keep up the steam for more than two or three minutes at one time. These statements obtained credit the more readily, as any improvement in the art of war which could be adopted by other powers, and which would have a tendency to place the weak upon a par with the strong, appeared likely to benefit other countries more than England.

The French government have determined to give our new system a fair trial. A series of experiments have been made at Greenwich, which were attended by the French engineers appointed for that purpose by the Duke d'Angouleme, together with one of his Aids, and Prince Polignac. This report was so satisfactory to the French government, that a contract was immediately made. An English engineer of the first class, and one who is very much employed hy this government, has joined me in the guarantee of the four points, which some of the English engineers have doubted, namely, the perfect safety of the generator; its indestructibility; the ability to keep the steam up, at any required temperature, for any length of time; and its great economy.

The piece of ordnance is to throw sixty leaden balls, of four pounds each, in a minute, with the correctness of the rifled musket, and to a proportionate distance. A musket is also attached to the same generator for throwing a stream of lead from the bastion of a fort, and is made so far portable as to be capable of being removed from one bastion to another. This musket is to throw from one hundred to one thousand bullets per minute, as occasion may require, and that for any given length of time. It was an observation made in my hearing, by his Grace the Duke of Wellington, that any country, defended by this kind of artillery, would never be invaded; and I am very confidently of this opinion also.

As soon as this machine is completed, it is to be exhibited to this government, and to several engineers from other powers, who are over here for that purpose. I have no fears for the result, neither has Mr. Lukens, since he witnessed the experiment made for the French government. He saw the steam-gun discharge at the rate of from 500 to 1000 balls per minute, and yet the steam blowing off at the escape valve during the whole time; he is equally confident, with myself, that the steam may be kept up in such a manner, as to discharge a constant stream of balls during the whole day, if required. As regards economy, I am within the truth when I say, that if the discharges are rapid, one pound of coals will throw as many balls as four pounds of gunpowder!

It has been stated, as an objection to the steam-gun, that it would take too long a time to get up the steam in case of an attack. To this I answer, that a very small quantity of fire will keep the generators sufficiently heated when there is no water in them; and that when there is any chance of their being suddenly wanted, they should be kept heated in this way. The heat of the generators would last long enough to give off steam until the fire was sufficiently increased to furnish a constant supply. For naval purposes, this cannot be an objection, as the steam must be always up. Lord Exmouth, after witnessing a few showers of lead, observed, that he believed a time would come, when a steam gun-boat, with two steam guns in her bow, would conquer any line of battle ship; and Sir George Cockburn said, that the mischief of it was, it would be to nations what the pistol is to duellists, it would bring all, whether strong or weak, upon a par.

To prove the safety of my engine, I have worked it under a pressure of 1400 lbs. to the square inch, or at a hundred atmospheres, and cut off the steam at one-twelfth of the stroke; this was merely done to manifest what could be effected with perfect security! My usual pressure is 800 lbs. per inch, cutting off the steam at one-eighth, and letting the steam expand to below 100 lbs. per inch. I let off at the dead-point at one flash: the manner of doing this I long to explain to you, but must first get my last patent sealed.

I am informed that our friend, Dr. Hare, thinks that I have ventured beyond my depth; in this opinion he is not singular, nor do I wonder that such an idea should prevail, after the publication of so many absurd tales respecting my engine. I had no knowledge of these publications, and of course no control over them. Indeed I have been extremely cautious about publishing any thing myself, or sanctioning it in others, my determination having been first to complete the essential improvements of which I have been in pursuit.

I presume that you have seen my last paper, on the compression of water, air, &c. Its publication by the Royal Society has created no small sensation among the philosophers of the old school. The council would not have allowed the reading of it, had not Dr. Wollaston and Sir Humphrey Davy witnessed many of the experiments. I shall soon publish an experiment with which I think Dr. Hare will be pleased, as it will, if I mistake not, prove practically what the Doctor has so ably attempted to establish theoretically, namely, that caloric is matter. The proof is simple and direct; and I am persuaded, that when you see it you will think it conclusive. I was led to the discovery of this fact by my experiments upon steam, the results of many of which have been very extraordinary and quite unexpected. One of the most striking is, the great repellent power of heat. I discovered that a generator, at a certain temperature, although it had a small crack in it, would not emit either water or steam. This fact I mentioned to a very scientific friend, who questioned its accuracy, and to convince him I tried the experiment; but he concluded that the expansion of the metal must have closed the fissure. To remove every doubt, I proposed to drill a small hole through the side of the generator, which was accordingly done. After getting the steam up to a proper temperature I took out the plug, and although we were working the engine at thirty atmospheres, nothing was seen or heard to issue from the plug-hole; all was perfectly quiet. I next lowered the temperature, by shutting the damper and opening the furnace door; a singing noise from the aperture in the generator was soon observable; and when a heated coal was held before it, a rapid combustion ensued. Nothing, however, was yet visible; but as the temperature decreased, the steam became more and more visible, the noise at the same time increasing, until, finally, the roar was tremendous, and might have been heard at the distance of half a mile. This was conclusive. I should mention, that at the aperture the iron was red-hot.

My belief is, that water cannot be brought into contact with iron heated to about 1200°, without a force equal to the maximum pressure of steam, which is equal to about 4000 atmospheres when water is heated to about 1200°. That pressure would, I believe, keep it in contact with iron at any degree of heat, and the steam would then be as dense as water. It is very evident that if it would require that force to keep the water in contact, heated as it was, at the vent hole, thirty atmospheres must be insufficient to effect this; but the experiment affords some data towards answering the question,—at what distance from the heated metal the water remained when under the pressure of thirty atmospheres? We may safely aver, that it exceed one-eighth of an inch, as the hole was one quarter of an inch in diameter.

After commencing this letter I ascertained that my patent was likely, in a few days, to pass the great seal, and have delayed forwarding it until I could give you some account of the effects upon the minds of those engineers, who were open to conviction, of an experiment performed before them. The patent has been sealed, and the engine has had its power and economy tested. The result has been so satisfactory, that an engineer, who employs at least three hundred hands, has taken orders to make engines (for I license them out), with the following guarantee, viz.—that of saving half the fuel, and three-fourths of the weight and bulk, with less liability of derangement than ordinary engines. This engineer, who is frequently employed by government, is now making an engine for steam navigation, with a nine-inch cylinder, and twenty-inch stroke; he joins me in guaranteeing it to be of sixty-horse power. It will not occupy more than one-sixth of the room, nor exceed one-sixth of the weight of the ordinary Bolton and Watt's engine, of the same power.

You may, my dear sir, depend upon what I have written; it is the result of actual experiment, and there is no fallacy in it. Having succeeded in making a piston which requires no oil, I am determined to ascertain the limits to which pressure can be carried. I am now making a small engine, strong enough to bear two thousand pounds per inch; and when done, you shall know the result. Nothing but the piston will limit the power.

The victory which I have obtained has been a glorious one for me. For the last three months many of the engineers had declared me insane, as I had asserted that I could condense and produce a vacuum under the piston, without either an air-pump or condensing water; but the tables are now turned, and my triumph over those who have assailed me is complete.

By the next packet you may expect drawings, &c. of my engine; and I hope, within one short year, to take a seat with my friend, Dr. Jones, by the side of a generator, sustaining a pressure of three thousand pounds to the square inch; for this pressure on the generator is required to produce a working power of two thousand pounds to the square inch upon the piston. Yours truly,

JACOB PERKINS.

LIST OF PATENTS FOR NEW INVENTIONS,

Which have passed the Great Seal since Aug. 21, 1827.

To Gabriel de Soras, of Leicester-square, in the county of Middlesex; Stacey Wise, and Charles Wise, of Maidstone, in the county of Kent, paper-makers; who, in consequence of a communication made to them by a certain foreigner resident abroad, are in possession of an invention of certain improvements in sizing, glazing, or beautifying materials employed in the manufacturing of paper, pasteboard, Bristol-boards, and other substances. Dated August 21, 1827.—To be specified in six months.

To John Hague, of Cable-street, Wellclose-square, in the parish of Saint George in the East, in the county of Middlesex, engineer; for a new method of working cranes or tilt-hammers. Dated August 30, 1827.—In two months.

To Benjamin Merriman Combs, of Birmingham, in the county of Warwick, ironmonger; for certain improvements on, or additions, to a pulley, machinery, and apparatus, used and applied for securing, fixing, and moving curtains and rollers, and other blinds. Dated August 30, 1827.—In two months.

To William Deltmer, of Upper Mary-le-bone-street, Fitzroy-square, in the sounty of Middlesex, piano-forte maker; for certain improvements on piano-fortes. Dated August 30, 1827.—In six months.

To William John Ford, of the parish of Mildenhall, in the county of Suffolk, farrier; for certain improvements in the make, use, and application of bridle-bits. Dated Sept. 6, 1827.—In two months.

To George Clymer, of Finsbury-street, Finsbury-square, in the county of Middlesex, engineer; for an improvement in typographic printing, between plane or flat surfaces. Dated Sept. 6, 1827.—In six months.

GILL'S

TECHNOLOGICAL REPOSITORY.

LXXIX.—*On Splitting, Cutting, and Polishing Diamonds, and on forming, mounting, and using Engravers', Glaziers', and Writing Diamonds, Diamond Dust, &c. By Mr.* EDMUND TURRELL, *Engraver.*

WITH FIGURES.

(*Continued from p.* 197.)

MR. BROCKEDON having kindly lent me one of his hard stones, which, owing to improper setting, has burst across its centre, and thus afforded an opportunity of exhibiting the exact form of the hole pierced through it by his directions, in order to fit it for the purpose of drawing gold or silver wire, or silver-gilt wire, in his patent mode, I have given an accurate representation thereof in plate IX.

In fig. 1, *a a* is a section of the stone, and *b, c,* the hole made in it. It will be seen that the stone is turned into the shape of a truncated cone, the widest and strongest end of it being judiciously chosen to form that part of the tool where the hole narrows most, and consequently where the greatest force is exerted to split or burst it in the act of drawing the wire; nor is this an unnecessary caution, as the instance now given proves.

The stone has been mounted or set in a conical hole made in a thick plate of brass to fit it exactly, and part of which is shown in section at *d d.* The stone has been secured from coming out of the hole in use by being burnished in, a bevel being turned around the wider end of it, over which the brass border around it has been closed in the lathe. The stone so mounted is shown in a front view of it, fig. 2, where a circular groove is seen, formed so as to allow of the burnishing operation to be performed with more convenience.

The hole was made by being first drilled through the stone held in the lathe, by means of various diamond drills, formed as described in page 131 of your last number, and then polished in the manner also there described, by the application of fine diamond powder upon steel wires.

Mr. Brockedon informs me, that he was limited in his power of drawing wire to any degree of fineness, not by any difficulty of drilling the holes in his stones, but solely by the inconceivable labour of forming steel wires sufficiently minute and perfect to polish them afterwards. He went to considerable expense in having a steel cylinder cut in a very finely-toothed file around its periphery, like those used in pin-making, in order to reduce the wire, when held upon it, in the manner of pointing pins, constantly turning it round backwards and forwards during the operation, and finally finishing it upon a cylindrical piece of Turkey oilstone, turned in the lathe. He has, however, promised to afford me farther particulars on this very interesting subject, when his leisure will permit him to do so.

On Lenses formed of Diamonds, Sapphires, &c.—Mr. Andrew Pritchard, of 18, Pickét-street, Strand, who is the first person who has shaped the diamond into a lens for microscopic purposes, has also since formed one of the sapphire, which is found to perform exceedingly well; and, from its lower price, and the superior facility in working it, will, no doubt, come into that general use which its superior advantages over lenses formed of glass so justly entitle it to.

Mr. Pritchard states, that if a lens be formed of glass, sapphire, or diamond, being ground in the same tool, and consequently to the same curve, the relative foci of these lenses will be as the one fifteenth, the one twenty-fifth, and the fortieth part of an inch; or their linear amplification will be, for the glass lens, 150 times; the sapphire, 250 times; and the diamond, 400 times. The chromatic dispersion of the sapphire, like the diamond, is no more than that of water.

(*To be continued.*)

LXXX.—*On Grinding and Polishing Minute Lenses for the Microscope. By the* EDITOR.

WITH FIGURES.

THE Editor, when quite a youth, being much attached to the use of the microscope, and only in possession of one of Wilson's, having lenses of low magnifying powers, was compelled, in order to form others of superior efficacy, to adopt such means of grinding and polishing them as he was able to afford, totally unassisted as he then was of all professional help or information upon the subject.

Having lately examined some of the lenses he then executed, he was much surprised, and not a little pleased, to find that their performance fully equalled that of the best he has since been able to meet with. This being the case, he thinks it may be desirable to publish the mode he then adopted, and especially as his method of forming the turning tools necessary to shape the grinding tools is entirely different, and appears to him to be a more facile one than that usually adopted; and his method of polishing the lenses is also exceedingly simple and efficacious.

In plate IX., fig. 3 is a section, and fig. 4 a top view of one of these turning-tools. Instead of being formed in the usual nail-head shape of these tools, as shown in fig. 5, it is made of a piece of flat steel, which being affixed upon the outer end, or flat face of a wooden chuck, screwed into the mandrel of a lathe, has then a circular groove turned in it, of the shape partly shown in the section, fig. 3, and in the view of it, fig. 4; that is, so as to turn a cylinder, *e*, of the diameter of the intended tool, of half the thickness of the steel plate, and according to the focus of the intended lens, and leaving the other half of the thickness of the steel untouched; the groove may be readily turned with the usual graver turning-tool. The one half of the cylinder *e* is then to be removed at its back, as shown in fig. 3, leaving its other half firmly adhering to the steel plate, which serves as a handle to hold and guide it by; and the excess of the steel may be removed, as shown in fig. 4. The tool is then ready to be hardened and tempered, and may be whetted nearly to an edge upon its flat face, taking care, however, not to injure its cylindrical periphery. The manner of using it is shown in fig. 4, where it is seen as supposed to be lying upon the lathe rest, and guided into a central hole previously turned in the end of a brass cylinder held in the lathe, so as to form the grinding-dish, or tool.

The glass to form the lens being cemented upon the ends of a slender wooden handle, and ground of a circular shape, as usual, may then be worked in the dish or grinding-tool thus formed, with emery and water, washed over in the usual manner for optical purposes, and as repeatedly described by us; and either when the dish is held and turned in the lathe, or as in fact the Editor did, by holding the dish and glass to be ground in his hands, and when the face became perfect and sufficiently smooth the polishing was effected by fastening a piece of soft buckskin leather upon the end of another wooden chuck screwed into the lathe mandrel, and having a hole made in its centre, so as to permit the leather to ply to the form of the lens; a little finely washed putty, (or the oxides of lead and tin) was then applied upon the leather with water, and by the action of the lathe very soon brought the surface of the lens to a fine polish. The other face of the lens was, of course, worked in a similar manner.

In this very simple, original, and efficacious manner, did the Editor produce lenses of less than the twentieth of an inch focus; and, indeed, there is no reason why those of much higher magnifying powers may not be as readily made.

LXXXI.—*On an excellent Test for proving the goodness of Steel. By* W. H. PEPYS, *Esq. F.R.S.*

MR. PEPYS has obligingly favoured the Editor with the following improved mode of determining the excellence of steel.

He has caused a number of steel cylinders to be made, of the hardest quality of English steel, which he has mounted upon an axis in a lathe, and after carefully hardening them, he has had them tempered, regulating the temperature of each by the thermometer, all but one, which remained of its full degree of hardness. In like manner, he has also caused another series of cylinders to be formed of wootz, or the East Indian native cast steel, and thus carries on his scale of comparative hardness to a still greater extent.

In order to test the goodness of any particular kind of steel, he causes a graver turning tool to be made of it, in the most careful manner, and applies the point of it in succession to the peripheries of the various steel cylinders, and accordingly as it cuts or acts upon them so he is enabled to form an accurate judgment of the nature of the steel, that of course being the best which will cut the hardest cylinder.

Of course the speed of the cylinders is always kept nearly the same, or otherwise the results would not be accurate; very hard steel or cast-iron being cut by an exceedingly slow rotary motion in the lathe, as we have formerly mentioned.

LXXXI.—*On an improved Mode of Heating Hot-houses, Green-houses, Conservatories, &c., executed under the direction of the Right Hon. the Earl of Powis, by Mr.* G. MANWARING, *Engineer, Marsh-place, Lambeth.*

WITH A PLATE.

THE object of this improvement is to preserve a more equal temperature throughout the stoves, green-houses,

&c., than can be obtained from the use of steam alone, as usual. This desirable object is effected by surrounding the steam-pipe with another pipe containing water; but, in order to render the particular mode of doing it more readily understood, we shall proceed to describe the figures contained in plate IX.

In fig. 6, A is the back wall of a stove, &c.; B, the front wall, and C C partition walls; D D is the main steam-pipe of cast iron, which is supplied from a boiler posited on the right hand of the steam pipe, and supplying steam at the pressure of about four pounds on the square inch; E E, a wrought iron steam pipe, proceeding from the main steam pipe D, and conveyed around and along three sides of the stove; F, a stop-cock, for regulating the supply of steam; G G, a cast iron pipe surrounding the steam pipe E E, and which is filled with water, and ordinarily heated by the steam to the temperature of from 180° to 190°, the water serving to equalize the temperature in the house; H, a cock, which conveys the water condensed from the steam into a funnel I, communicating with a pipe J, by which it is led into another pipe K K, which passes to the boiler. The wrought iron pipe E E is connected with the cast iron water pipe G G at each end of it, by what is termed a bonnet, a section of which is shown in fig. 7, where G indicates the end of the cast iron pipe as being enlarged, and furnished with two short stems L L, cast solid with it. Into the circular mouth of this enlarged part of the pipe G a ring, projecting from the inner face of a cast iron plate M, is fitted, and which plate has two holes in it, through which the stems of two screwed eye-bolts pass, the eyes of which are hooked upon the stems L L, and the whole are bound together by the screwed nuts N N, a coil of hempen yarn, saturated with white lead ground in oil, being previously lodged in a circular recess formed around the flat end of the pipe G, to render the joint water-tight. A hole is also made in the centre of the plate M, to allow the steam pipe E to pass through;

and upon the steam pipe a flange, or circular plate, is secured, by being brazed with speltar solder, with three holes in it, to admit the heads of as many screws, by which it is secured to the cast iron plate M, a ring of pasteboard, coated on each side with white lead and oil, being previously interposed, to render the joint tight. In order to allow of the expansion and contraction of the cast iron water pipes, from the alternating effects of heating and cooling them, the following contrivance has been adopted by Mr. Manwaring:—O O, &c., represent what are usually termed spiggot and faucet joints; one of these is represented in section, on an enlarged scale, at fig. 8, where G G represent the ends of the pipe; P, an enlarged part, forming the faucet part of the joint; L L, two short stems, similar to those already described, with screwed eye-bolts fitted to them, which pass through holes made in the cast iron plate Q (shown separately in fig. 9), and which plate has a larger hole in its centre, which receives the spiggot part, R, of the joint within it. This cylindrical part is made smooth on its outside, and is wrapped around with hempen gasket steeped in tallow; and when the parts are connected together by the screwed nuts N N, a sufficient degree of motion is allowed, to counteract the prejudicial effects which would otherwise have been produced from the expansion and contraction of the pipe. The wrought iron steam pipe is retained in its proper place within the cast iron water pipe by resting upon cast iron supports, similar to that shown in fig. 10, which are placed at proper distances apart for that purpose, the steam pipe being posited a little below the centre of the water pipe. The parts of the steam pipe are united by screws in the manner of gas pipes, and as shown in fig. 11; and in case of uniting them at the corners, an elbow is formed, having the female screw made upon it, into which the other part of the pipe is to be screwed, as shown in fig. 12. The water and steam pipes are made gradually to descend from the place where the steam enters to where it escapes, in order that the condensed water produced from it may be conveyed again to supply the boiler. And, in order to obviate the mischiefs which might arise from the expansion of the water by the heat upon the pipe G G, a cylindrical vessel, S, fig. 6, is provided for it to enter and rise therein, and thereby to remove that evil.

In cases of extraordinary cold happening, an extra steam pipe, T T, fig. 6, is provided, into which the steam is admitted by the stop-cock U, the water from the condensed steam passing off into the funnel I, by the cock V; W W, &c., are hollowed cast iron rollers, upon which the water pipes G G rest; these roll upon the flagged pavements, and allow the pipes to traverse to and fro, as required by their expansion and contraction.

Mr. Manwaring calculates, that a foot in length of heated pipe will heat one hundred cubic feet of air; and that, supposing the boiler to be of the capacity of one hundred cubic feet, the steam pipes ought to be two inches in diameter, and the surrounding water pipes six inches.

LXXXII. — *On Casting, Grinding, and Polishing Speculums, for Reflecting Telescopes, Microscopes, &c.* *By the Rev.* JOHN EDWARDS, *B.A.*

(Concluded from p. 248.)

THE manner of working or figuring the metal upon this tool, and indeed upon all the succeeding tools, is taught in Dr. Smith's Optics, or by Mr. Mudge, in the Philosophical Transactions, vol. LXVII., part 1. I shall, therefore, refer my readers to these publications, as I only mean to give my own improvements. When the metal is brought to a true figure, it must be taken to a convex tool, formed with stones from a place called Edgedon, in Shropshire, situated between Ludlow and Bishop's Castle. These stones or hones are of a fine grain, and will easily cut the metal, and bring it to a fine face. Indeed the blue hones*, used in general by the opticians for this purpose, will scarcely touch the metal; and it will be a laborious undertaking to bring the metal to a fine face, so as to take out all the marks from the emery, by the common blue hones. By means, however, of the abovementioned stones, they may be easily ground, and truly figured. The bed of stones should be of a circular figure, and but very little larger than the metal intended to be figured upon it, viz., about two-tenths of an inch, but not more, for a speculum of four or five inches in diameter. If the tool is made considerably larger than the metal, it will grind the metal perpetually into a larger sphere, and by no means of a good figure: if the metal and tool are of the same size exactly, the metal will work truly spherical; but it is apt to shorten its focus less and less, unless the metal and tool are worked alternately upwards. It had, therefore, better be made a little larger† than the mirror, when it will not alter its focus. Too much water should not be used at a time upon the hone pavement, or the figure will be very bad, which may easily be seen, by the face of the metal appearing of different degrees of brightness in different parts of it. When the metal is brought to a very fine face and figure by the bed of stones, it is ready to receive a polish: but before I shall give any directions with regard to the manner of polishing it, I must mention a circumstance or two I had inadvertently passed over. The metal must not be cast too thick, or it will never take the parabolic figure intended to be given to it. The best proportion I have found for this purpose is a metal of four inches and a half in diameter, and eighteen inches focus, should be four-tenths of an inch thick at the edge of it: the back of the mirror should be convex, to strengthen it, and to cause it to spring and adhere to the polisher uniformly. Its convexity should be equal to its concavity on the face, that the metal may be everywhere of an equal thickness. The handle should be made of lead, of the same convexity and concavity as the metal; its thickness about double that of the metal, and its diameter three-fourths of that of the speculum; it should have a hole in the middle, with a copper or iron screw on it, so as to put it, together with the mirror to which it is fastened with pitch, on a collar lathe, in order to smoothen and finish the edge of the metal, which may be done by holding a fine file to it when in the lathe at the first, and afterwards one of the abovementioned stones.

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* Should any one, however, make use of the common blue hones, he should use as little water as possible when the metal is put upon them, as they will cut much better when barely wet than if much water is used upon their faces.

† About one-twentieth part greater in diameter.

On polishing the Metal, and giving it the true Parabolic Figure.—The rough grinder, of an elliptical form, is now to be covered with common pitch. I generally make my own pitch, by boiling tar in a ladle or crucible, over a very slow fire, till it becomes of the consistence I require, for a great nicety is required in the degree of the hardness of the pitch. The harder the pitch is the better figure it will give to the metal, as it does not alter its figure in working as soft pitch does; besides, the metal will acquire a lustre upon a polisher moderately hard, so as to show objects reflected upon it as vivid and as near their colour as possible; but if the pitch is too soft, some of its finest particles will always adhere to the face of the metal, and form a very fine and thin cuticle or covering upon its surface. This circumstance is rendered very evident, by viewing any white object in the metal (a sheet of white paper for example), when that fine cuticle, or thin surface of the pitch upon the speculum, will cause it to show the object of a dingy brown colour, and not of its usual whiteness. Pitch may be easily made harder, by adding a proper quantity of resin. I often use equal quantities of pitch and resin, so as to make the mixture just as hard, when cold, as to receive an impression from a moderate pressure of my nail. A polisher made with pitch and resin has this advantage, viz. though it is hard, yet it is not so brittle as when pitch only is used, and made harder by boiling it; and consequently is not so liable to break or chip off at the edges, and thereby scratch the metal. Pour the melted pitch and resin, when pretty cool, from the crucible upon the elliptic tool*, so as to cover it everywhere, when spread upon it with an iron spatula, about the thickness of a half-crown piece. If the covering be too thin, it will continually alter its figure, by the heat it acquires in working the metal upon it, and thereby give a bad figure also to the speculum. When it is somewhat cool, lay a piece of writing paper upon the surface of the pitch, press the face of the mirror upon it, and you will find the polisher will be nearly figured to the form of the speculum. If it has not taken the exact figure everywhere, which would appear by the fine marks of the paper upon the pitch, gently warm the surface of the pitch, and repeat the operation as before, until you have formed it to the exact figure of the metal†. With a penknife take away now all the superfluous pitch from the edge of the polisher, and with a conical piece of wood form the hole in the middle accurately round; in other words, let the pitchy surface be every where of the exact size and shape as the lead tool which is under it. It may be necessary to mention, that the hole in the middle of the polisher should go quite through the tool (for a particular reason), and should be made of the same size or somewhat less than the hole in the middle of the speculum. This is a necessary caution; and indeed I have always found that small mirrors, without any hole in the middle, will polish much better, and the figure will be more correct, if the polisher has a hole in the middle of it. The powder I prefer above all others to give a most exquisite lustre, is colcothar of vitriol, and not putty. Putty gives metals a white lustre, or, as workmen call it, a silver hue; but good colcothar of vitriol will polish with a very fine and high black lustre, so as to give the metal polished with it the complexion of polished steel. To know if the colcothar of vitriol is good, put some of it into your mouth, and if you find it dissolve away it is good; but if you find it hard and gritty between your teeth, then it is bad, and not well burned. Good colcothar of vitriol is of a deep red, or a deep purple colour, and feels soft and oily when rubbed between the fingers; bad colcothar of vitriol is of a light red colour, and feels harsh and gritty. The colcothar of vitriol should be levigated between two surfaces of polished steel, and wrought with a little water; when it has worked dry you may add a little more water, to carry it lower down to what degree you please. When the colcothar of vitriol has been wrought dry three or four times it will acquire a black colour, and will be low enough, or sufficiently fine, to give an excellent lustre. This levigated colcothar of vitriol I put in a small phial, and pour some water upon it, and afterwards I use it for polishing the metals, in the same manner that washed putty is directed to be made use of for that purpose. I always put on a large quantity of washed colcothar of vitriol at once, so as to saturate the pitch, and form a coating of the colcothar, and very rarely make use of a second application. If a second or third application of colcothar should be found necessary to bring the metal to a fine lustre, or to take out any scratches upon its face, use it very sparingly, or you will destroy the polish you have already attained. When the metal is nearly polished, it will always generate some black mud upon the surface of the mirror, and also upon the tool. Wipe it now away from the face of the metal with some very soft wash leather, though if too much of this mud be taken away it will not polish so well. Indeed, a little experience in these matters will better suffice than a volume written upon the subject.

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* The elliptic tool must be made pretty warm, or the pitch will not adhere to it.

† When the polisher is brought to its true figure, gently warm it at the fire, and with the edge of a knife divide it into several squares, by pressing the edge of the knife gently upon the pitch; these squares, by receiving the small portion of the metal that works off it in the polishing, will cause the figure of the speculum to be more correct than if no such squares had been made. The polisher may also be formed without the writing paper, by dipping the mirror into cold water, and afterwards pressing it upon the surface of the pitch (when it is somewhat cool), and by repeating this operation till it has taken the exact figure of the metal.

In regard to the parabolic figure to be given to the metal, no particular caution is required in the polishing; the elliptical tool will always cause the speculum to work into an accurate parabolical figure, supposing the transverse and conjugate diameters bear the true proportion to each other, and the metal is not too thick to prevent it always from adhering firmly and uniformly to the polisher. Should the pitch prove too soft it will give way, and alter the figure a little. This circumstance will render the figure of the mirror sometimes a small degree short of the parabola, and sometimes a very little beyond it; but by a little perseverance the correct figure is very easily acquired. I could very easily give the reader the reason why an elliptical tool of a proper proportion, will always give a parabolic figure; and if the transverse diameter is increased, then it will always give an hyperbolical figure; but as I am writing upon the practical part of making reflecting telescopes, and not the theory, I will not offend his patience. To convince any one of the certainty of my assertions, let him polish a metal of two and a half inches diameter, and nine and a half inches focus, upon an elliptical tool, whose diameters are two and a half and three inches; and I can assert, he will always find the metal, when polished (if it is not too thick), beyond the parabola, or it will always prove hyperbolical. If he polishes it upon a circular tool, in the common way, with cross strokes in every direction possible, using a few round strokes every time he changes his position, he will find it always prove spherical, and consequently short of the parabola. A very little experience in these matters will convince any one of the ease and certainty of giving the great speculum a parabolic figure, by polishing it in a common manner only, with cross strokes in every possible direction upon an elliptical tool of the proper dimensions, in which, for common foci and apertures, viz., two and a half to nine and a half focus, or 3,8 inches in diameter, to eighteen inches focus, the diameters should be ten to nine. The shortest diameter of the ellipse being accurately the same as the diameter of the metal, and the longest diameter of the ellipse to the shortest diameter, as ten to nine.

JOHN EDWARDS.

Ludlow, July 19, 1781.

Dr. Maskelyne, late astronomer royal, states, that—"Mr. Edwards's telescopes show a white object perfectly white, and all objects of their natural colours; very different from common reflecting telescopes, which give a dingy copperish appearance to objects. I found, by a careful experiment, that they show objects as bright as a treble object glass achromatic telescope, both being under equal circumstances of areas of the aperture of the object metal and object glass, and equal magnifying powers; whereas the diameter of the aperture of a common reflecting telescope must be to that of an achromatic telescope as eight to five, to produce an equal effect.

"NEVIL MASKELYNE."

An Account of several Compositions of Metals and Semi-Metals, on which Trials were made, to find out the most proper Mixture for the Specula of Reflecting Telescopes.

By the Rev. JOHN EDWARDS. *B. A.*

1. Copper and tin[*], equal parts; very bad, soft, and of a blue colour.

2. Copper with arsenic, ⅛; but little different from the first.

3. Tin 2, copper 1; much worse than the preceding ones.

4. Copper 32, tin 16, arsenic 4[†]; black and brittle.

5. Copper 6, tin 1¾, arsenic 1; very indifferent.

6. Copper 32, tin 14, arsenic 2; a very good metal.

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[*] By tin, I always mean grain tin.

[†] Nitre was added to fix the arsenic.

7. Copper 32, tin 13½, arsenic 1; not quite so good as the sixth.

8. Copper 32, tin 13½, arsenic 1½; a good metal.

9. Copper 32, tin 15, arsenic 2; much better than any of the above.

10. Copper 6, tin 2, arsenic 1; compact, but very yellow when polished.

11. Copper 3, tin 1¼; compact, and whiter than the tenth.

12. Copper 32, tin 14½; a pretty good metal; but polishes too yellow.

13. Copper 32, tin 15, arsenic 2, flint glass* in powder 3; very bright, but rotten.

14. Brass 6, tin 1; compact, but too yellow.

15. Two parts of 11th composition, and one part of 14th composition; compact, but much too yellow when polished.

16. Brass 5, tin 1; somewhat whiter than the 14th.

17. Brass 4, tin 1; a good metal, but rather yellow.

18. Brass 4, tin 1, with arsenic $\frac{1}{10}$; whiter than 17th.

19. Brass 3, tin 1†; will not polish well.

20. Brass 2, tin 1; of a sparry nature.

21. Tin 3, brass 1; too soft, being only a kind of hard pewter.

22. Brass and arsenic, equal parts; a dirty white colour.

23. Brass, copper, and arsenic, equal parts; a dingy white.

24. Brass and platina, equal parts; very difficult to fuse and mix well together; is then malleable, and of a dingy white colour, like 22.

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* Flint glass was added as a flux. See Shaw's Chemistry, p. 225. Note, the 10th is the composition of Sir Isaac Newton. See Appendix to Gregory's Optics, p. 221. The 11th, 14th, and 15th, are the compositions of Mr. Molyneaux. See Smith's Optics, vol. ii., p. 304. And the 12th is the composition of Mr. Mudge. See Philosophical Transactions, vol. xlvii. p. 298.

† These compositions are mentioned by Neri and Kunckel, in Neri's Art of Glass-making. Surely they never tried these compositions themselves, but took them upon the report of other authors, as the 12th will not take a good lustre, and the 21st is very soft, like hard pewter, therefore highly improper for specula, which should be as hard as possible.

25. Copper 32, tin 14, crude antimony 4; black and rotten.

26. Copper 32, tin 14, crude antimony 1; blueish and rough grained.

27. Copper 32, tin 15, arsenic 4, bismouth 2; much too rotten.

28. Copper 32, tin 15, arsenic 3, bismuth 1; much too yellow when polished, and appears also porous.

29. Copper 2, zinc 1; a pale malleable metal.

30. Copper and zinc, equal parts; still malleable, and rough grained.

31. Copper 32, tin 15, arsenic 4, zinc 4; a good metal, but does not take a high lustre.

32. The 31st composition fluxed with corrosive sublimate; a compact and hard metal, but rather yellow when polished.

33. Copper 32, tin 16; a most beautiful, brilliant composition, but much too brittle and rotten. N.B. Unless the copper is very pure this composition will be of a dark blue colour, as fifteen ounces of grain tin will generally saturate two pounds weight of copper.

34. Copper 32, tin 17; blueish and rough grained.

35. Copper 82, tin 18; blueish and rough grained.

36. Brass 2, zinc 1; nearly of a gold colour.

37. Brass and zinc equal parts; a pale gold colour, and rough grained.

38 Spelter 4, tin 1; very rotten.

39. Copper and crude antimony, equal parts; of a sparry nature.

Remarks by the EDITOR.

The late ingenious Mr. Samuel Varley made a composition of bees'-wax and colcothar melted together, of such a degree of hardness that, when cold, it would just receive the impression of the nail. He used this for polishing glass lenses with colcothar and water, having first warmed and wetted it, and moulded it to the form of the lens. No tool was, however, here used to support it, like the pitch, used by Mr. Edwards. It answered most admirably in practice; and Mr. Cornelius Varley, his nephew, still continues to use it with great satisfaction. It likewise answers equally well for polishing specula.

LXXXIV.—*On improvements lately made on his Patent Metallic Pistons, by Mr.* JOHN BARTON, *Engineer, Seward-street, Goswell-street, London.*

WITH FIGURES.

IN our *Technical Repository,* Vol. IV., we gave a description, accompanied by a plate, of this piston, together with several testimonies of its superior advantages, from persons who had experienced the great benefits of it in use. We have now to add some variations in its construction, by which it is rendered both lighter and simpler.

In our former plate, the piston was shown to have two horizontal helical springs applied to each of the four wedges, thus making eight in all, so as to cause them to extend outwardly and thereby to urge the four circular segments, as well as the points of the wedges, into contact with the inside of the cylinder. In plate IX, fig. 13 is a section, and fig. 14 a plan, of the simplified construction of it, by which it will be seen that the four wedges, *a a a a,* are all now acted upon by a single central helical spring, which uniformly extends them all, and causes them, of course, to make the circular segments, *b b b b,* press against the inside of the cylinder. The external ends of the wedges are now also blunted, instead of being left sharp, as originally. Mr. Barton now likewise makes the circular segments hollow, as shown by the dotted lines in fig. 14, by which means, whilst all the bearing parts still retain their original surfaces, the piston is rendered much lighter.

We are glad to find that the piston continues to merit the commendations we formerly bestowed upon it; at the same time, however, we learn that many piracies upon the patent are continually made, as must inevitably be the case with all really good inventions, and especially with the great evils under which the patentee labours, in having to defend his invention in our courts of law, at his own sole cost; whilst the numerous invaders of his rights all mutually contribute to support their invasion.

LXXXV.—*On the Manufacture of Oil from Beech-mast. By the celebrated* AARON HILL*.

SIR, *London, July* 5, 1799.

WE have an old English proverb, which affirms that it is much easier to ask questions than to answer them. I have lately met with a pamphlet, which has tempted me to propose a number to your correspondents, but have been somewhat intimidated by the above consideration, which might, perhaps, prevent your favouring me with their insertion in your excellent work. It has, however, occurred to me, that a kind of middle way may be devised, to render the business more fair and reasonable. If the account I now send you should be thought to contain information enough to render it acceptable to your readers, it will but be fair to place it in the balance against the questions I hope to have resolved.

The pamphlet I allude to is Aaron Hill's "Account of the Rise and Progress of the Beech-oil Invention," (8vo. 112 pages), which bears date in the year 1715, and, as it appears, was given away. This ingenious man, equally known for his works of imagination, his projects, and the tried rectitude of his principles, passed the latter part of an active life, of sixty-five years, in a state of poverty. His project of making oil from the beech-mast was, therefore, either unsuccessful, or, what is more probable, it failed from circumstances dependant either on himself personally, or those who where engaged with him. The elucidation of this object, which is of no small importance to our woollen and other manufactories, cannot surely be foreign to the purposes of your journal; and even if any of your correspondents should favour us with historical facts, tending to show the inutility of the scheme, the public would, no doubt, receive it with gratification on the mere inducement of curiosity. The pamphlet before me contains also notices of inventions of some curiosity and apparent value, though related almost as concisely, as the "Century of Inventions" of the Marquis of Worcester; upon the whole, they show that when a man of ability leaves the beaten path of the current affairs of life, to pursue the remote analogies of improvement, new results spring up around him, to the practical accomplishment of which the life of man is totally inadequate, and in the pursuit of only a few of which the utmost endeavours of an unfortunate individual may be exerted without effect, until at length he sinks under the extent and variety of his plans and occupations.

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* We have extracted this interesting article from Vol. III. of Nicholson's Quarto Journal of Natural Philosophy," &c. It becomes of additional importance now, when we have such increased demands for oil for gas lighting. Nay, the mast might be used entire, by charging the retorts with it at once, and without the expence of previously extracting the oil from it.—EDITOR.

To your discretion, sir, I submit an abridged account of this pamphlet. If, from the promise of utility, it should appear fit for the public eye, I shall receive pleasure from your decision; if the contrary, I shall feel no pain from the free operation of a power which I think you worthy to exercise.

The treatise consists of a general introduction on the nature and advantages of new inventions, and the prejudices they have to contend with; with an account of the particular invention which forms the chief subject of the address. The author complains of his sufferings from the misrepresentations of ignorance and malice, and after relating the ancient story of Thales, the Milesian, who enriched himself by buying up oil previous to a scarce year of olives, which he foresaw, he gives an account of the discovery of the stocking engine, as follows:—

"It is not out of some men's remembrance, that a young gentleman of no fortune, a student in Oxford, fell in love with an inkeeper's daughter of that town, whose circumstances were very narrow. He had philosophy enough to despise superfluous wealth, and judgment to foresee the necessity of a competence, but love was headstrong, and too hard for reason; so that after a year or two's ineffectual delay, they bid defiance to their stars, and had courage enough to marry. The scholar gained a wife, and lost a fellowship, the only small subsistence he before depended on."

The narrative proceeds to acquaint us, that the father-in-law, who during his lifetime despised the unproductive acquisitions of his daughter's husband, died miserably poor, and left this couple in a state of extreme indigence, their whole support being derived from the industry of the wife in knitting stockings.

In this situation, rendered more anxious by the certainty of an event which promised to increase their family, and suspend that labour which afforded their subsistance, the husband could only waste his hours between his books and his sighs, with ineffectual meditations on schemes for relief. In these reflections, his eyes were often involuntarily fixed on the motion of his wife's fingers at her work. This attention was at last more steadily directed, and his imagination set to work on the inqury, whether the same operation could not be performed by machinery. Both parties directed their ingenuity to this research, and at length succeeded in making a stocking loom, to their own great relief and comfort, and lasting benefit to the public. *Query.* Who were the parties here spoken of?—The author then mentions other speculations, and the numerous inventions which distinguish cultivated nations; from whence he deduces the evident consequence, that improvements ought to be encouraged. He refers to Stow, and other authors, for accounts of the calumnies and opposition which were made to the project of the New River, and occasioned the ruin of the projector of that noble work. The burning of bricks with pit-coal, which was first done at the beginning of the seventeeth century; the improvement of glass, introduced by the Duke of Buckingham; the project of James the First, to introduce the growth of silk; the establishment of the woollen manufacture from Flanders; and the manufacture of rape-oil, are among the instances he offers in favour of projects; and to those he adds three speculations of discoveries of his own, which are little more than hinted at. Speaking of the first, he affirms, that there is a common vegetable, almost the growth of every hedge, which yields a wax, finer than that used for candles, at an expence so inconsiderable, that he is very sure, that in the practice of the thing, a pound of such wax candles would not cost three-halfpence! I will not annex a formal query, what this vegetable may be, but simply observe, that an inquiry into the combustibility and other properties of vegetable products, with regard to this great object of affording light, appears to deserve the attention of curious men.

Another discovery, which he says he has lately bestowed upon an honest gentleman, is, that by the charge of a single penny exclusive of the price of coals, he can produce a gallon of aqua-vitæ, much fitter for all common uses than the thrice-rectified spirit of malt. *Query*: What is the date of the general practice of distilling spirit from molasses? Much earlier, I suppose, than this period. I am disposed to think, that the project of Aaron Hill may have consisted in the use of some saccharine product, which was cheap but not plentiful; and, consequently, could not be procured in sufficient quantity, or suddenly rose in price as soon as a demand was felt.

Another object of information is, that acorns, dried and ground, are a much better and cheaper tanning material than oak bark, and that it is used in Italy, and all over the Archipelago, by the name of *valonia*. Is this true, in point of fact?*

The last project is a scheme of finance, which is related, or alluded to, in terms of the highest promise; but as there is no hint of the nature of the plan, and as political arithmetic is a science in which mistakes are not only possible, but very likely to be made, I shall pass it over without further remark.

The rest of the book contains a history of the discovery and practice of the art of making oil from beech-mast. The author first states, that the raw material is very plentiful, and that every bushel is found to yield two gallons of much better oil than that of olives, called Seville, or Gallipoli oil! He informs us, that he made the discovery at Naples, in 1699; but being at that time only fifteen years of age, he thought no more of it till 1722, when he was induced to inquire into the demand for oil, by the soap-makers, clothiers, and others, and also from the dealers, and the entries at the Custom House. He was surprised at the extent of the consumption, and immediately undertook to ascertain the practicability of procuring the beech-nut in sufficient plenty, as well as the sources from which he might derive the necessary assistance for establishing the business. He met with no encouragement in his guarded applications to men of capital, till after he had taken out a patent, at which period he found no difficulty in obtaining a subscription of twenty thousand pounds, which he raised by engaging to grant annuities of fifty per cent. on the sum subscribed. He afterwards raised one hundred thousand pounds, upon an engagement to receive beech-mast from the subscribers, at 100 per cent. profit to them, for two years. With this stock he proceeded to establish his works, and procure orders; the latter of which amounted to two and twenty thousand tuns of oil, at 40*l.* a tun, or near a million sterling! The reports concerning the beech-mast appear to show, that the quantity in plentiful years is prodigiously great; but that this happens about every third year. It also appears in his foreign correspondence, not only that the beech-nut is very plentiful on the continent, but that its application to the purpose of manufacturing oil had been known and practised for near a century in the northern parts of France. One of his correspondents points out, that this oil is preferred by many to the best olive oil; that it had long before been mentioned in commendation by Evelyn, in his "Discourse on Trees;" and that in Bretagne, the millers convert the beech-mast into oil, for the price of one sous per bushel, and the oil-cake, which is used for feeding cattle.

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* The *cups* of the acorns, called *valonia*, are now greatly employed here in some kinds of tanning.—EDITOR.

After this mass of apparently good evidence, I should be glad to know if it be my ignorance only which leads me to suppose that there is little if any beech-oil sold in the market? If a bushel of beech-nuts be worth less than sixpence, and these will afford, by mere mechanical pressure, two gallons of oil, equal in quality, or even much worse than olive oil; how happens it that the consumer now pays five shillings a gallon for whale oil for lamps, and sixteen shillings a gallon for olive oil in flasks?

To return to my history.—It appears, on the whole, that Aaron Hill did manufacture this oil, and that the samples were highly approved by the British clothiers, who gave him large orders; that the year immediately subsequent to the formation of his subscription company, proved very unfavourable to the beech-mast, which was lighter and less oily than in good seasons; that his subscribers became alarmed after having paid their first instalment, which was forfeited in case of failure in the last payment; that the patentee, instead of insisting upon his bargain, had the honourable spirit to offer them a repayment of their money, with a profit of twenty-five per cent. That the offer was accepted, and actually performed to the second class of subscribers, and one-third part of the original annuitants; the remainder, to the amount of about thirteen thousand pounds, choosing to retain their annuities.

Here I must remark, that the scheme must have realized some considerable profit, since the advantage allowed to the subscribers, over and above their money returned, must have been near eight thousand pounds; besides which, there were, undoubtedly, many expences and disbursements made. Is it to be supposed, that these were all paid out of the thirteen thousand pounds which were not withdrawn?

The object of the pamphlet was, to circulate proposals for establishing a new company, to which the old patent, subject to the annuities, was to be assigned for twenty-five thousand guineas, and one twelfth part of the profits, under certain regulations, expressed in a deed, enrolled in Chancery for that purpose. The shares were five thousand, at forty pounds a-piece, besides the premium of five guineas on each share. What became of it afterwards I know not.

I remain, sir, your constant reader,

X. X.

LXXXVI.—*On the Premature Publication of a Patented Invention, Mr.* L. W. WRIGHT'S *Cranes.*

ABOUT a fortnight since, we were shown in confidence an improved crane, invented by Mr. L. W. Wright, engineer, of Lambeth; and for which he had only two months before obtained a patent for England, and was soliciting others for Ireland and Scotland; and in consequence, had six months allowed him as usual, to make his experiments in, and, finally, to specify the results thereof. How greatly then were we surprised to find in a periodical publication, on the 20th ult., and, consequently nearly four months before his specification became due, a surreptitious account of his patent crane, accompanied by a wood-cut, and a notice that his patent was not yet enrolled; and this, with a view to depreciate his invention, to the utmost of their power!

Now, really after the great expense the patentee must inevitably incur, merely in the cost of his three patents, not including the much greater expence, of constructing models and machines, to realize his invention, we cannot but think that he has been most illiberally treated, and, not improbably injured, in the fair remuneration he naturally looked for; and, in fact, we believe, that if he can but bring proof that he has lost a single order for a crane, in consequence of this misrepresentation, an action for damages will lie against all the parties concerned in this premature exposure. And we would ask, what right has any individual to arrogate to himself the privilege of condemning an invention in this early stage of its progressive improvement! For, even during the course of the fortnight we have been acquainted with the invention, it has received considerable additions, and undergone several changes in its construction, the natural results of experience; and what farther improvements the patentee may have it in his power yet to make upon it, in consequence of his greater experience in its performance, it is impossible to say. It is surely too much to condemn a patentee on the first specimen he has produced; and it has hitherto been usual, and indeed but fair, to await the enrollment of the specification, before proceeding to comment upon it. However, we now see that another crane has since been patented by another individual, and the specification of which becomes due earlier than Mr. Wright's; and we must therefore conclude, that the indecent haste in publishing and endeavouring to condemn the former one, has been caused by a wish, if possible, to forestall it in the market.

Twenty of Mr. Wright's cranes have, nevertheless, been ordered by the Directors of the West India docks, and are actually delivered there, and in operation. The direcwhich may be traced lines as clear and well defined as those made on paper with Indian ink; and also a solid preparation, which will produce the same results as the common crayons used by artists. Hitherto, it has only been possible to effect this by forming a kind of soap, by the combination of fatty or resinous substances, with an alkali. This soap, when liquid, does not spread as do grease and oils; and when in a solid state, it has such a degree of consistency as to enable the artist to produce upon stone all the effects of a drawing. But as soapy bodies are, in general, soluble in water, and as the water with which it is necessary to moisten the stone, and consequently the drawing, before applying the printing ink, would destroy the drawing, by dissolving the soapy substance with which it was formed it was found necessary to find a means of reducing this soap to the state of a fatty body, insoluble in water. This is effected by spreading over the stone, and over the drawing, an acid, which, by uniting with the alkali of the soap, reduces the latter to the state of grease. This operation, of which we shall say more hereafter, is called the *preparation*.

Lithographic ink, if good, will be soluble in distilled water, which is capable of perfectly dissolving common soap. It ought to flow freely from the pen, and not spread on the stone; it must also be capable of forming extremely fine lines, and should be very black, in order to render the work of the artist perfectly clear and distinct. The most essential quality, however, is that of imbedding itself firmly in the stone, so as to reproduce the most delicate touches of the drawing, and to afford a great number of impressions; in order to do this, it is necessary that it should be capable of resisting the acid which is spread over it in the preparation, so as not to have its fatty particles either removed or altered.

A host of recipes for making lithographic ink and crayons, have been published, and scattered both in Germany and in France. M. Senefelder, in his work, gives eight receipts for making this drawing ink; yet, assuredly he has not published that which he considers the best. We think it superfluous to give these receipts, as it would only serve to create uncertainty in chusing from among them, and especially, as we consider them all, more or less inferior to that which we have used for a long time, and with uniform success. It was after having tried a great number of compositions that we gave the preference to the following:—

Lithographic Ink.

	Drachms.
Soap, from suet, or tallow,—dry	30
Mastic, in tears,	30
Soda, of commerce,	30
Shell-lac	150
Fine lamp-black,	12

Soap made of tallow is to be preferred to that prepared from oil. But as soap is more or less hard, according to its age, and the dryness of the situation in which it has been kept, it must not be used in exactly the above proportions with the other articles, without regard to its being either moist, or dry. To obviate this source of error, and to obtain the exact proportions, the soap should be cut with a knife into thin slices, and exposed to the sun and air until it is perfectly dry; it is then to be put into a box lined with paper, and thus kept, in a very dry place, until it is wanted for use. The best lamp-black, which is the product of the combustion of resin, should be used.

In order to melt these materials, a copper, or cast-metal skillet, should be used, which should be furnished with a wooden handle; it will also be found convenient for it to have a lip on its edge, in order that the material may pass more readily into the moulds, particularly when crayons are to be made. The soap is first put into this vessel, which is then to be placed over a brisk fire in a chafing dish; when this is well melted, the shell-lac is to be thrown in, which will fuse very readily; the soda is then to be added, a little at a time, and after this the mastic, taking care to stir it with a spatula, furnished with a wooden handle; lastly, the lamp-black is gradually put in, stirring it between every successive addition, until the mixture is complete. A very brisk fire is used, that the materials may be perfectly fused. The shell-lac is apt to swell up; it is, therefore, put into the skillet gradually, that it may not boil over. When all these materials are well incorporated, they are poured out on a plate of cast-iron, made very warm, and rubbed over with oil, in order that the composition may be easily detached from it. Before the mass is poured on the plate, ledges are formed around it with pieces of wood, which serve to prevent the mass from running off, and enables us to preserve it of an equal thickness throughout; when these pieces of wood are removed, the composition is to be cut into strips, by means of a knife, which should be guided by a straight ruler; this must be done whilst the composition is warm. Little sticks are thus formed, similar to those of Indian ink; it would, however, be more convenient to have moulds, in which to pour the composition.

Many who have written on the subject of lithography, have recommended, not merely the melting, but the partial burning of the materials, with which lithographic ink and crayons are to be composed; but this is a bad method, since it is impossible, in this way, always to obtain the same combinations; as some portion of the materials would thus be wholly destroyed. The means of obtaining good ink, must depend on the nature of the materials, and upon their being duly proportioned to each other; and to accomplish these ends, it is not necessary to have recourse to combustion.

The ink of which we are about to give the composition, is used either with the pen, or the camel's hair pencil, for writings, dotted, and aquatinta drawings, those of a mixed character, or those intended as imitations of wood, or other engravings.

Autographic Ink.

We proceed to describe, practically, the process for preparing the autographic ink, or that kind, which is suitable for transfering on to stone, the writings, or drawings, which have been executed on paper, prepared for that purpose.

This ink ought to be mellow, and somewhat thicker than that used immediately on the stone; so that when it is dry on the paper, it may still be sufficiently viscous, to cause it to adhere to the stone by simple pressure. The following is the manner of preparing the ink:—

	Drachms.
Dry soap,	100
White wax, free from tallow,	100
Mutton suet,	50
Shell-lac,	50
Mastic,	50
Lamp-black,	30 to 35

These materials are to be melted in the way we have described for lithographic ink.

Autographic Paper.

The operation, by which a writing or drawing is transferred from paper to stone, not only affords the means of abridging labour, but also of producing the writings, or drawings, in the same direction in which they have been traced; whereas, when they are executed immediately on stone, they must be performed in a direction opposite to that which they are eventually to have. Thus it is necessary to draw those objects on the left, which, in the impression, are to be on the right hand. To acquire the art of reversing subjects, when writing or drawing, is both difficult and tedious; while, by the aid of transparent, and of autographic paper, impressions may be readily obtained, in the same direction as that in which the writing, or the drawing, has been made.

In order to make a transfer on to stone of a writing, a drawing in lithographic ink, or in crayons, or an impression from a copper-plate, it is necessary, first, that the drawing, or transcript, should be on a thin and flexible substance, such as common paper; second, that it should be capable of being easily detached from this substance, and transferred entirely on to the stone, by means of pressure. But as the ink with which a drawing is traced, penetrates the paper to a certain depth, and adheres to it with considerable tenacity, it would be difficult to detach them perfectly from each other, if, between the paper and the drawing, some substance was not interposed, which, by the portion of water which it is capable of imbibing, should so far lessen their adhesion to each other, that they may be completely separated, in every point. It is to effect this, that the paper is prepared, by covering it with a size, which may be written on with facility, and on which the finest lines may be traced, without blotting the paper. Various means may be found of communicating this property to paper. We will give a preparation, which we have always found to succeed, and which, when the operation is performed with the necessary precautions, admits of the finest and most delicate lines being perfectly transferred, without leaving the faintest trace on the paper. For this purpose, it is necessary to take a strong, unsized paper, and to spread over it a size, prepared of the following materials:—

	Drachms.
Starch,	120
Gum Arabic,	40
Alum,	21

A moderately thick paste is made with the starch, by means of heat; into this paste is thrown the gum arabic and the alum, which have been previously dissolved in water, and in separate vessels. The whole is mixed well together; and it is applied warm to the sheets of paper, by means of a brush, or a large, flat, hair-pencil. The paper may be coloured, by adding to the size, a decoction of French berries, in the proportion of ten drachms. After having dried this autographic paper, it is put into a press, to flatten the sheets; and they are made smooth, by placing them, two at a time, on a stone, and passing them under the scraper of the lithographic press.

If, on trying this paper, it is found to have a tendency to blot, this inconvenience may be remedied, by rubbing it with finely powdered gum sandarach. We give below another recipe, which will be found equally useful; and which has the advantage of being applicable to thin paper, which has been sized. It requires only, that the paper be of a firm texture :—

	Drachms.
Gum tragacanth, - - - - - - - - - - - - - -	4
German glue, - - - - - - - - - - - - - -	4
Spanish white*, - - - - - - - - - - - - - -	8
Starch - - - - - - - - - - - - - - - -	4

The tragacanth is to be put into a large quantity of water, to dissolve, thirty-six hours before it is mixed with the other materials. The glue is to be melted over the fire, in the usual manner. A paste is made with the starch; and after having, whilst warm, mixed these several ingredients, the Spanish white is to be added to them, and a layer of this sizing is to be spread over the paper, as already described: taking care to agitate the mixture with the brush, to the bottom of the vessel, that the Spanish white may be equally distributed throughout the liquid. We will hereafter point out the manner in which it is necessary to proceed, in order to transfer writings or drawings.

We must not omit to notice two autographic processes which facilitate, and abridge, this kind of work, when it is desired to copy a *fac simile*, or a drawing in lines. The first of these methods, is, to trace, with autographic ink, any subject whatever, on a transparent paper, which is free from grease, and from resin; like that which is known in commerce, by the name of *papier vegetal*; and, to transfer it to stone, this paper is to be covered with a transparent size; this operation is very difficult to execute, and requires much address, in consequence of the great tendency which this paper has to cockle, or wrinkle, when it is wetted. Great facilities will be found from using tissue paper, impregnated with a fine white varnish, and afterwards sized over. In the second process, transparent leaves, formed of gelatin, or fish glue,* are employed; and the design is traced on them, with the dry-point, so as to make an incision; these traces are to be filled up with autographic ink, and thence transferred. We will describe, in their proper places, these processes, as well as that of transferring a lithographic, or a copper-plate engraving.

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* Finely washed whiting.—Editor.

(*To be continued.*)

LXXXVIII.—*On the causes of the inadequate protection afforded by Lightning-rods in some cases, and the means of insuring their perfect competency: also a refutation of the prevalent idea, that Metals are peculiarly attractive of Electricity.* By R. HARE, M.D., *Professor of Chemistry in the University of Pennsylvania*†.

IN some of our American newspapers, a letter has been republished from the London "Times," calculated, as I conceive, most perniciously to lessen the confidence of the public in metallic conductors, as a means of protection against lightning. In common with many other persons, the author of the letter appears to suppose, that metals are peculiarly attractive of electricity; and infers that, when a metallic rod is attached to a house or ship, a discharge of electric fluid may be induced from a cloud, which, otherwise, would not have been sufficiently near to endanger the premises. Nothing in my opinion can be more erroneous than this notion. The truth is, that the earth and the thunder clouds being in opposite electric states, the electric fluid tends to pass from one to the other, in order to restore the equilibrium. The atmosphere being a non-conductor, through which a discharge cannot be accomplished without a forcible displacement of air, any solid body rising above the earth's surface, which may be more capable than the air, of transmitting electricity, is made the medium of communication. Metals being preeminently capable of acting as conductors, the transmission of electricity is made through them with proportionably greater facility. Yet they do not attract it more than other substances similarly electrified. A glass, or wooden ball is as readily attracted by the excited conductors of an electrical machine, as a ball of metal; and as much more than a metallic point, as the superficies of the ball may be greater than that of the point.

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* The manner of preparing these leaves, shall be hereafter given.

† From the *Franklin Journal*.

Nothing to me appears more unfounded, than an idea lately suggested, that the attraction between a ship and a thunder cloud can be increased, by the presence of a pointed metallic rod, surmounting the main mast.

If houses, or vessels, have been struck with lightning, while provided with conductors, it is, in my opinion, owing to the conductors being improperly constructed; or having no adequate connexion with the earth. The power of any body to receive an electric discharge, is dependant on the conducting power of the medium in which it terminates, no less than upon its own. A metallic rod, held by a glass handle, or entering a mass of pounded glass, or dry sand, would not be more efficatious as a conductor, than a glass rod similarly situated. If terminated by an imperfect conductor, as for instance, by earth or water, its power is reduced in proportion to the imperfection of the medium thus bounding it. This influence of the media, in which conductors terminate, has not been sufficiently insisted upon, in treatises on electricity. I should not consider a metallic rod, terminating without any enlargement of surface in the water or the earth, as an adequate protection against lightning; but were such conductors to terminate in metallic sheets, buried in the earth, or immersed in the sea, or, by a connexion duly made with the iron pipes, with which our city is watered; or the copper, with which ships are generally sheathed, I should have the most perfect confidence in their competency.

It is not only important that the points of contact between the metallic mass, employed to afford lightning an adequate passage, and the earth or water in which it terminates, should be so multiplied as to compensate for the inferior conducting powers of the earth or water; but it is also necessary that the conducting rod be as continuous as possible. When conductors are to be stationary, as when applied to buildings, they should consist of pieces screwed together, or preferably joined by solder, as well as by screwing. Where flexibility is requisite, the joints should be neatly made, like those of the irons in fall-top carriages; and should be rivetted so as to ensure a close contact at the juncture.

In all cases, the ordinary, but important precaution, of having the end terminate above, in a fine clean point, should be attended to. Where platina tips cannot be had, multiplying the points, by splitting the rod into a ramification of pointed wires, may compensate for the diminished conducting power, arising from it.

The efficacy of the point, or points, is, however, dependant upon the continuity of the conductor of which I have already spoken: since it is well known, that, if a pointed rod be cut into parts, so as to produce intervals, bounded by blunt terminations, its efficacy will not be much greater than if it had no point; because the fluid will, in that case, pass in sparks, instead of being transmitted in a current. It is on this account that I object to chains, or rods joined by loops, or hooks and eyes. The error of supposing that a metallic rod, must be more capable of attracting electricity injuriously, because of its known wonderful power in transmitting it will be evident, when it is understood that the only difference between metals and other bodies, arises from the superior power of transmission. Hence, when by a defective communication with the earth or sea; the efficacy of the metal, as a conductor, is diminished, or destroyed, its influence over a charged cloud is proportionably lessened. It follows, therefore, that so far as it acts, its action must be beneficial, unless its lower termination should, by an inconceivable degree of ignorance or inattention, be so situated as to render it more easy for the electrical fluid to leave the rod, and pass through a portion of the house or vessel, than to proceed by means of the rod, into the earth or sea.

Thus Richman was killed by a conductor which he employed to receive electricity from the clouds, and to convey it to an electrometer, necessarily insulated: under these circumstances, the head of the Professor being about a foot from the conductor, he became a part of the channel of communication with the earth. Had the apparatus been surrounded by a cage of wire, and this duly connected with a metallic rod, soldered to a sheet of metal buried in the earth, Richman might have made his observations with perfect security. That with due precaution, experiments, analogous to his, are not productive of injury to the operator, is rendered evident, by the subjoined quotation, from Singer's Electricity.

I must premise, that the apparatus, by means of which the phenomena alluded to were produced, consisted of a wire a mile long, supported and insulated upon very high poles, and terminating in the house of the electrican, Andrew Crosse, Esq.

" The approach of a charged cloud, produces sometimes positive, and at others negative signs at first; but whatever be the original character, the effect gradually increases to a certain extent, then decreases and disappears, and is followed by the appearance of the opposite signs, which gradually extend beyond the former maximum, then decrease, terminate, and are again followed by the original electricity. These alterations are sometimes numerous, and are more or less rapid on different occasions; they usually increase in intensity at each repetition, and at last a full dense stream of sparks issues from the atmospherical conductor to the receiving ball*, stopping at intervals, but returning with redoubled force. In this state, a strong current of air proceeds from the wire and its connected apparatus; and none but a spectator can conceive the awful, though sublime effect of such phenomena. At every flash of lightning, an explosive stream, accompanied by a peculiar noise, passes between the balls of the apparatus, and enlightens most brilliantly, every surrounding object; whilst these effects are heightened by the successive peals of thunder, and by the consciousness of so near an approach to its cause.

"During the display of electric power, so awful to an ordinary observer, the electrician sits quietly in front of the apparatus, conducts the lightning in any required direction, and employs it to fuse wires, decompose fluids, or fire inflammable substances; and when the effects are too powerful to attend to such experiments securely; he connects the insulated wire with the ground, and transmits the accumulated electricity with silence and with safety."

LXXXIX.—*On Facile Means of procuring Beautiful Objects for the Microscope. By the* EDITOR.

THE Editor, in June last, brought home from a pond in the neighbourhood of this metropolis, a bottle containing water abounding in animalcula, and having plenty of the leaves of the lemma, or duck-weed floating upon its surface. This he put into a vessel of white earthen-ware, of about four inches in height and in diameter. This vessel he placed on the cill outside of a window, and ever since it has afforded him a never-failing supply of living and most entertaing objects for his microscope.

At first, the stems of the lemma were surrounded by clusters of the bell polype, which formed interesting objects; but these were soon consumed; and now, in the end of October, but few of the leaves themselves have preserved their green colour; they having, by the continual consumption of the animalculæ, to which they afford food, now become nearly transparent, and themselves forming beautiful objects for the microscope.

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* That is, a ball communicating with the earth by an adequate metallic conductor.

Upon removing one of the leaves from the vessel, with the web of the feather left upon the smaller end of a crow-quill, from which the remainder of the webs on both sides had been stripped off, and which thus thus formed a very convenient kind of flat pencil, and laying it upon a slip of glass half an inch broad, with its underside uppermost; the glass slip having previously had a sort of shallow mound or wall raised upon it, in the middle part of it, by heating the glass till it would melt a stick of sealing-wax, melted and drawn to a fine point previously, and then drawing lines across it in two places, at a proper distance apart, with the sealing-wax, and continuing them along each side, thus forming as it were, an exceedingly shallow kind of pond, but which, however, is fully adequate to the free display of the various interesting movements of the animalculæ. More water from the vessel was then added, with the help of the feather, and the whole was covered with a small slip of glass, less than the twentieth part of an inch in thickness, and thus the whole was rendered conveniently manageable, and placed upon the stage of the microscope for inspection.

In some of the larger cells formed in the leaves the wheel-animalcule takes up its abode, and is often to be found in considerable numbers. In others of them several varieties of the bell-polype and others will always be found; and we have frequently found that beautiful animalcule, termed the Proteus, by Baker, from its wonderful facility of changing its form, with its remarkably long neck playing in an infinite variety of directions with great swiftness. Other smaller kinds of animalculæ, in great numbers, are also found adhering to the leaves of the lemma; and it has, besides, the valuable property of keeping the water perfectly fresh and sweet, whilst it retains any portion of its green tints; in short, it is highly desirable for every proprietor of a microscope, who would wish to secure a great variety of interesting objects in constant readiness, to adopt a similar means of obtaining them.

On examining the stems of some flowers which had been standing in water a fortnight, and were just in that state when they are ordinarily thrown away, the Editor thought that the maceration would most probably fit them for displaying the admirable structure of their bark and leaves, and accordingly he took some of the loosely adhering mucilaginous matter, which adhered to the stem of a stock-gilly flower, and placing it between two glass slips, well wetted with water on their insides by the help of the feather, he repeatedly opened and closed the two glasses by raising their opposite edges, and thus succeeded in causing the water to pass repeatedly over and amongst the mucilaginous matter, and thus wash away the more soluble parts of it; he also frequently wiped away the turbid water, and supplied fresh; and at length, upon subjecting the remaining more solid parts, well floated with water between the two glass slips, in the mode pointed out to his notice lately by the celebrated Professor Amici, he was much gratified to find that he was furnished with a most beautiful display of the curious spiral or helical sap vessels of the leaves, the punctured air-vessels, the skins of the leaves, the longitudinal fibres of the bark, and, which was more surprising, the exceedingly singular branched hairs, or down of the plant, still preserving, after all the maceration, washing, &c. its original extraordinary form, as lately published by us.

It would be utterly vain to attempt, by the employment of such coarse instruments as the knives, scissars, needles, &c. usually sold with botanical microscopes, to produce a display of these delicate parts at all equal to the above;

and the great ease with which it was accomplished is not the least recommendation in its favour.

Recent leaves of plants, of a rather succulent kind, may, by a treatment somewhat similar to the above, and by sliding the one slip of glass over the other, also be made to appear beautiful objects for the microscope, particularly in their upper and under skins, which are thus freed from the palpy matter contained between them.

In our number for August last we stated that we had first pointed out to the notice of Mr. R. Carpenter the beautifully terminated minute hairs of the larva of a dermestes, figures of which, on a highly magnified scale, we also gave; and that we also directed the attention of Mr. J. Cuthbert to the same object. Mr. Cuthbert has since mentioned to the Editor, that some of his friends have thought that his small Amici's reflecting microscope was incapable of shewing these objects, from the manner in which that statement was drawn up. Now we must say that the Editor had not the least idea that such an inference could be drawn, as, on the contrary, he had viewed these objects himself in Mr. Cuthbert's microscope. All that the Editor intended to state being, that he had discovered them with his Varley's single microscope, and first pointed them out to the notice of Mr. Carpenter and Mr. Cuthbert.

LXXXIX.—*Remarks upon Water-Wheels, and upon some prevailing errors respecting the Application of Water as a Motive Power**.

I SUPPOSE that at the present day no man, who professes to be capable of directing the construction of a water-wheel, or of estimating the amount of a water power, is ignorant of the fact, that water falls through a distance of about sixteen feet in the first second. But I suspect that many who assume the above qualifications do not know the ratio of increase, either of the distance or the velocity. I have drawn this conclusion, not only from conversations with several practical engineers, but also from essays published in our scientific journals. As an instance of this latter, I will select, for its convenience of reference, an article on water-wheels, published in this Journal (vol. i, p. 103), which being the production of a practical engineer, and having passed the inspection of a scientific committee, may be considered as corroborating my commencing observations. In the third paragraph of that article is the following sentence: "As a falling body, water descends at the speed of nearly 16 feet in the first second; and it will appear evident, that if a water-wheel is required to be so driven, that the water with which it is loaded has to descend 10, 11, or 12 feet per second, at which rates wheels are generally constructed to work, that a very large proportion of the power is lost."

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* From the Franklin Journal.

Here, in the first place, we find speed, or velocity, confounded with the distance fallen in the first second, whereas the latter is 16 feet, and the former is accelerated, from nothing at the commencement, to 32 feet per second at the end of the first second; so that this part of the sentence conveys, strictly, no intelligible meaning. It is, nevertheless, made a standard, by a comparison between which, and any given velocity of a water-wheel, we are to infer the loss of power sustained through excess of speed; thus, in the case of a wheel whose velocity is 10 or 12 feet per second, comparing these numbers with the mysterised number 16, the writer concludes, "that a very large proportion of the power is lost." The height of the fall which indicates the whole amount of the power is not mentioned, but surely to estimate the proportion between a defined part and an undefined whole is impossible.

The vague appreciation of first principles, which I impute to this writer, is exhibited conclusively in his closing remarks on certain establishments which he had inspected. At the corn-mill on the Rariton, as well as the flour-mills on the Brandywine, he represents the fall of water to be 20 feet, the diameter of the wheels about 16 feet, and the speed of their skirts about 10 feet per second, worked by a head of 4 feet; from which he draws the deplorable conclusion, that "in all these establishments there is not obtained 50 per cent. of the power of the water used." But a little simple arithmetic will furnish the proprietors of these mills with a more satisfactory account, and perhaps prevent their incurring the expense of a new arrangement, with a view to realizing the last 50 per cent. of their power.

The velocity of the skirts of the wheels is 10 feet per second; this velocity is acquired by water in a descent of 18¾ inches*. But the water issues upon the wheels from under a head of 4 feet. under which its effluent velocity is 16 feet per second. Now, although the wheels are not much assisted by the impulsive power of the water striking upon them with a velocity 6 feet greater than their own, yet they are certainly not retarded by it, and therefore on no ground can we make the loss more than 4 feet, which is but one-fifth of the whole power, or fall of 20 feet, leaving four-fifths as the proportion of the power effectively applied, instead of less than one-half, as asserted in the article under consideration.

Our water-works at Fair Mount (Philadelphia), which so justly excite the pride of our citizens, and their gratitude to those public spirited individuals, to whose enterprise and skill we are indebted for them, come next into review; but as his information on some important points in this case is incorrect, I need not enter into an examination of his conclusions; I will, however, venture to offer my own views on the subject of the economy and application of the power consumed.

The head and fall at high tide is 6 feet 6 inches, the wheel at this time wading 2 feet in the tide; when the tide is out, it is 8 feet 6 inches, and as the tide rises and

* See the annexed Table.

falls about 6 feet twice in 24 hours, I suppose the wheels wade, more or less, for about 7 or 8 hours out of every 24, I will therefore take the average head and fall to be 8 feet.

The velocity of the skirts of the wheels is about 12 feet per second, which is due to a fall of 27 feet. The water issues upon the wheel from under a head of 12 inches; its effluent velocity is therefore 8 feet per second; but the direction given to it by the form of the aperture through which it issues is at an angle of about 45 degrees with the breast of the wheel; of course its velocity, in the direction in which the skirt of the wheel moves, cannot be more than 5½ feet per second; but as the wheel moves at the rate of 12 feet per second, it must expend some of its power in impressing its own velocity on the water*. The whole loss of power may be estimated thus:—The velocity of the wheel, 12 feet per second, is acquired by water in falling 27 inches. The water issues on the wheel from under a head of 12 inches. The velocity in the required direction is 5½ feet per second, which is due to a fall of 5⅔ inches. The difference is so much lost, viz. 6⅓ inches. Total loss, 33⅓ inches. Or thus:—The velocity of the water in the required direction is that which is due to a fall of 5⅔ inches. Immediately on striking the wheel, it receives a velocity due to a fall of 27 inches. The difference indicates the power expended by the wheel in giving it that velocity, 21⅓ inches. The water comes on the wheel, below the surface of the dam, 12 inches. Total loss, as before, 33⅓ inches.

Thus it appears, that of the whole power expended, one-third is lost by the excess of the speed, and the manner in which the water is introduced into the buckets, and two-thirds are effectually applied to the work.

The height through which the water is raised from the dam to the reservoir is 96 feet; the water which raises it falls 8 feet; therefore, supposing that all the power could be effectually used, and no loss sustained on account of leakage, friction, &c. 12 gallons on the wheels, descending 8 feet, should raise 1 gallon to the reservoir 96 feet; whereas, every gallon that reaches the reservoir costs an expenditure of between 30 and 40 gallons from the dam. Suppose the average expenditure to be 36 gallons to raise 1 gallon, then but one-third of this power is accounted for at the reservoir; and, as I have shown, that one-third is lost by the excessive velocity of the wheel, &c.; the remaining one-third must be charged to friction, leakage, &c. This last third, however, is one half of the effective power.

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* Every visitor at Fair Mount must have noticed the noise produced by the percussion of the floats of the wheels upon the water entering the buckets.

I have made a calculation of the distances and velocities attained by falling bodies in various fractional parts of a second, which is here introduced for the information of those practical and theoretical engineers who have avoided the labour of doing it for themselves.

I have proceeded on the following established data, viz.

Heavy bodies fall through a distance of 16 feet in the first second, at the end of which they have acquired a velocity of 32 feet per second; the velocity increases as the times—the distance increases as the squares of the times.

THE TABLE.

Time of descent.		Distance fallen.		Velocity attained per second.	
		Ft.	*In.*	*Ft.*	*In.*
1-128th of a second		0	$0\frac{1}{90}$	0	3
2-128ths	—	0	$0\frac{1}{21}$	0	6
3-128ths	—	0	$0\frac{2}{19}$	0	9
4-128ths	—	0	$0\frac{3}{16}$	1	0
5-128ths	—	0	$0\frac{2}{7}$	1	3
6-128ths	—	0	$0\frac{2}{5}$	1	6
7-128ths	—	0	$0\frac{3}{5}$	1	9
2-32nds	—	0	$0\frac{3}{4}$	2	0
3-32nds	—	0	$1\frac{2}{3}$	3	0
4-32nds	—	0	3	4	0
5-32nds	—	0	$4\frac{2}{3}$	5	0
6-32nds	—	0	$6\frac{3}{4}$	6	0
7-32nds	—	0	$9\frac{1}{4}$	7	0
1-4th	—	1	0	8	0
9-32nds	—	1	$2\frac{1}{5}$	9	0
10-32nds	—	1	$6\frac{3}{4}$	10	0

Time of descent.		Distance fallen.		Velocity attained per second.	
		Ft.	*In.*	*Ft.*	*In.*
11-32nds	—	1	$10\frac{2}{3}$	11	0
12-32nds	—	2	3	12	0
13-32nds	—	2	$7\frac{2}{3}$	13	0
14-32nds	—	3	$0\frac{3}{4}$	14	0
15-32nds	—	3	$6\frac{2}{11}$	15	0
one-half	—	4	0	16	0
17-32nds	—	4	$6\frac{1}{5}$	17	0
18-22nds	—	5	$0\frac{3}{4}$	18	0
19-32nds	—	5	$7\frac{2}{3}$	19	0
20-32nds	—	6	3	20	0
21-32nds	—	6	$10\frac{2}{3}$	21	0
22-32nds	—	7	$6\frac{3}{4}$	22	0
23-32nds	—	8	$3\frac{1}{5}$	23	0
three-fourths	—	9	0	24	0
25-32nds	—	9	$9\frac{1}{5}$	25	0
26-32nds	—	10	$6\frac{3}{4}$	26	0
27-32nds	—	11	$4\frac{2}{3}$	27	0
28-32nds	—	12	3	28	0
29-32nds	—	13	$1\frac{2}{3}$	29	0
30-32nds	—	14	$0\frac{3}{4}$	30	0
31-32nds	—	15	$0\frac{1}{5}$	31	0
1 second	—	16	0	32	0
2 seconds	—	64	0	64	0
15 seconds	—	3,600	3	480	0
30 seconds	—	14,400	0	960	0
one minute	—	57,600	0	1,920	0

To determine what proportion of a given water-power is lost by a given velocity of the wheel, it is only necessary to ascertain what distance the water must descend to acquire that velocity, then this distance, compared with the whole fall, answers the question. Thus: suppose the whole fall to be 10 feet, and the velocity of the wheel 4 feet per second, this velocity is due to a fall of 3 inches, or one-fortieth part of the whole fall, which is the proportion sought, Or suppose the velocity to be 13 feet per second, which is due to a fall of 2 feet 75 inches, then the loss is rather more than one-fourth of the whole fall of 10 feet. But it must be especially noted, that these estimates embrace the supposition that the water issues upon the wheel in the direction of the motion of its skirt, and precisely at that distance below the surface of the dam which answers to the velocity of the wheel. Inattention to this particular is a very important and frequent cause of loss.

E. M.

XC.—*On a Colourless Lac-Varnish.* *By* Robert Hare, *M.D.*[*]

It has been a desideratum among artists to render shell-lac colourless; as, with the exception of its dark hue, it possesses all the properties essential to a good spirit varnish, in a higher degree than either of the other resins. A premium of a gold medal, or thirty guineas, "for a varnish made from shell-lac, or seed-lac, equally hard, and as fit for use in the arts, as that at present prepared from the above substances, but deprived of their colouring matter," has long been, and is still offered by the Society in London for the encouragement of arts, manufactures, and commerce. These ends are perfectly attained by the process given by Dr. Hare, which leaves nothing to desire, except on the score of *economy*. Were the oxymuriate of potash to be manufactured in the large way, the two processes, that of making the salt, and of bleaching the resin, might be very advantageously combned.

Mode of bleaching Shell or Seed-Lac.—Dissolve, in an iron kettle, one part of pearlash, in about eight parts of water, add one part of shell, or seed-lac, and heat the whole to ebullition. When the lac is dissolved, cool the solution, and impregnate it with chlorine, till the lac is all precipitated. The precipitate is white, but its colour deepens by washing and consolidation; dissolved in alcohol, lac bleached by the process above-mentioned, yields a varnish, which is as free from colour as any copal varnish.

Chlorine, or oxymuriatic acid may be formed, by mixing, intimately, eight parts of common salt, and three of the black oxide of manganese, in powder. This mixture is to be put into a retort; four parts of sulphuric acid, diluted with an equal weight of water, and afterwards allowed to cool, is to be poured upon the salt and manganese, when the gas will be immediately liberated, and the operation must be quickened, by a moderate heat. If the mixture be made, without the sulphuric acid, and this be added in small portions, the heat generated by this means will be sufficient to disengage the gas, without the aid of a lamp. A tube leading from the mouth of the retort, must be passed into the resinous solution, when the gas will be absorbed, and the lac precipitated.

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[*] From the *Franklin Journal* for August.

Remarks by the EDITOR.—This is the first account of this process which has yet appeared in this country. It is but fair, however, to add, that Mr. George Field, of Isleworth, whose ingenious apparatus for colour-making was formerly rewarded by the Society of Arts, and published in its Transactions, as well as in our *Technical Repository*, did two years since, bring a similar process to the above before that society, and this session he has been rewarded for it, and it will appear in the ensuing volume of the Society's transactions, together with another process for affecting the decolouration of the shell-lac, without the employment of chlorine, invented by a young assistant in Apothecaries' Hall; so that the public will be put into possession of three methods of effecting this truly desirable object, in consequence of the encouragement held out by the Society of Arts.

XCI.—*On the Preparation and Use of Mastic Varnish: particularly suitable for Paintings in Oil.* By JOSHUA SHAW, *Esq.*

SIR, *Philadelphia, July* 12, 1827.

AMATEURS and collectors of paintings are frequently at a loss for a varnish, properly prepared, and suited to the purpose of restoring and preserving the colours in works of art. I submit the following observations on the preparation of a very good one, and the best mode of applying it to the surfaces of pictures painted in oil.

Experience has shown, that for this purpose, mastic varnish is, in general, preferable to any other, especially in the hands of inexperienced persons; and, with but few exceptions, even in those of the adept. This varnish is generally prepared, by dissolving the mastic in spirits of

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[*] From the *Franklin Journal.*

turpentine, over a sand-heat, in a well glazed earthen, or in a copper vessel; occasionally shaking, or stirring it about, until the mastic is entirely dissolved, which will take place before it arrives at a boiling heat; after which it is strained through a piece of calico, in preference to linen, as it is less apt to give off lint, which is very trouble some when it gets into the varnish: it is then to be put into a bottle, well corked, and placed for two or three weeks where the light of the sun can strike it, which will cause a large precipitation of mucilaginous matter to take place, and renders it as transparent as water. It is now to be poured off into a clean bottle, and put by for use. This is the mode of preparing that commonly sold in the shops; but to ensure a varnish that can be depended upon, the following observations must be attended so. Let all the mastic be bruised by a muller on a painter's grinding stone, which will immediately detect the soft or oily tears, which must be rejected; as when dissolved in the mass, they prevent the varnish from drying hard, having a greasy or *tacky* surface*. The next point of importance, is to procure, if possible, turpentine which has been distilled a second time; but, where this is not to be had, the best kind sold in the shops must be taken; but it must be perfectly clear and colourless, otherwise, good varnish cannot be obtained; it must not be furnished through an oily measure (which is but too commonly the practice) but be poured out of the carboy, without shaking or disturbing it. If any doubts are enentertained as to its purity put about two table spoonfuls into a common white saucer, and let it evaporate in the sun, which will be effected in two or three hours; and if it leave a greasy residuum, or a soft sticky mass, it must be rejected; that only is good which entirely disappears. Thus prepared, with good spirit of turpentine, and with mastic bruised and picked, the two ingredients may be put up into a clean bottle, when the resin may be dissolved without heat, by half an hour's shaking in the hand; it must then be strained, and afterwards treated as before recommended.

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* The greatest advantage of Mr. Field's colourless lac-varnish is, *its perfect freedom from tackiness.* The wax, naturally contained in lac, being also removed, in the process by which it is freed from its colouring matter.—Editor.

The French sometimes prepare their gum in spirit of wine (pure alcohol), but it is subject to chill on the picture, and produces, in time, a kind of white scale over it, which injures its lustre.

When it is prepared after the manner recommended, six ounces of pounded gum are mixed with fourteen ounces of pure spirit of turpentine, which may, if found too thick, be diluted with more turpentine. It should be laid on the picture with a soft, flat, camel's-hair brush, as it is called, but which, however, is made of the hair obtained from the squirrel's tail. The varnish should always be laid on with as much dispatch as possible, keeping it alive, as the artists term it, and floating after the brush. It may be proper to observe, that no kind of varnish should be applied to any painting without first cleaning it, nor to a newly painted picture until it is perfectly hard, to effect which requires five or six months. Before varnishing, be careful to remove all grease from the surface, by a coat of whiting (not lime) mixed with water, and laid on so that it covers and entirely obscures the picture; this should be allowed to dry, and to remain on for one or two hours, when it must be entirely removed by a sponge and some clean rain water; then perform the operation of varnishing in a still room, free from lint and dust.

It will sometimes happen that a picture, when the surface is smooth, will look too bright and glaring, which is both disagreeable to the eye and injurious to the effect of the picture. To remedy this defect, after the varnish is quite dry, say in ten or fifteen days, sponge the picture all over with pure rain water for about one or two minutes, and having squeezed the sponge, and made the picture as dry as the sponge will leave it, pass lightly a clean silk handkerchief over it with great rapidity, until it becomes perfectly dry, when a clear lucid appearance will pervade the whole picture. Breathing occasionally on the picture to damp it will assist the operation while chafing it with the handkerchief.

I am, sir, your's very respectfully,

To Dr. Thomas P. Jones. JOSHUA SHAW.

XCII.—*On the different Black Colours. By the late celebrated* WILLIAM LEWIS, *M.B. and F.R.S.*

(*Continued from page* 217.)

On the Preparation of common Writing Ink.—Common writing ink is prepared from galls, or other astringent vegetables, and green vitriol (sulphate of iron), steeped or boiled in water or other liquors. The ingredients, in different receipts, are set down in very different proportions: in some, six parts of galls are directed to one of vitriol; and in others, three or four parts of vitriol to one of galls: some order the weight of the liquor to be equal to that of the vitriol and galls together, others fifteen or sixteen times as much.

Most of the common inks have a capital imperfection that though at first of a pretty good colour, yet in length of time they decay, some sooner and others later, the writing becoming scarcely legible, or even entirely disappearing, of which too many instances are known to those who have records and other writings of any considerable age. The preparation and improvement of this useful fluid, on whose duration so much depends, becomes therefore a very important object.

The ingredients being known, it was hoped, that by a proper set of experiments, the best ink they are capable of affording, in regard both to the durability and beauty of the colour, could not escape discovery. Though length of time be the proper test of the absolute duration of inks, it was presumed that a few years would be sufficient for judging of their comparative durability; and that in this comparison, some assistance might be obtained from exposing the writing for some months to the sun and weather, by which the influence of time on colours is hastened in a remarkable degree; dyed clothes exposed for a month or two in the sun in summer, lose more of their colour than they do in an age, when kept close from the air. With these views, about fifteen years ago, I engaged in a set of experiments, of which the general results are as follow.

1. *Experiments for determining the best preparation of ink, with vitriol and astringents.*

When common ink, or a black infusion of galls and vitriol, is diluted largely with water, and suffered to settle, the black matter, as already observed, falls to the bottom, and the liquor becomes colourless. If such a mixture contained more vitriol than the galls could saturate and decompose, it was judged that the redundant vitriol would remain dissolved in the liquor, and strike a black colour with fresh galls; and that, on the contrary, if the quantity of galls employed at first was more than sufficient for the decomposition of the vitriol, the liquor would in like manner retain the redundant impregnation of the galls, and strike a blackness with fresh vitriol; so that by trying, till such proportions of the two should be found, as that the liquor, after the precipitation, should produce no blackness with a fresh addition of either ingredient, the proportions requisite for the exact saturation might be discovered.

Many trials were accordingly made on this principle. When the quantity of galls was several times greater than that of the vitriol, an addition of more vitriol to the liquor, after settling, produced a fresh blackness; and when the vitriol greatly prevailed, an addition of galls had the like effect. But there were several intermediate mixtures, with proportions considerably different from one another, in which no blackness could be perceived to arise from the addition of the one or the other ingredient. By taking a medium between the quantities, in those trials where one or the other did produce a sensible colour, it was reckoned that about equal parts of the two were the mean proportions, which could receive no additional blackness from a further increase of either. In these, and all the other experiments made with galls, the Aleppo, or blue galls, were the sort employed; and care was taken, by boiling or long infusion, to get out as much of their virtue, as can be expected to be done in practice.

Different infusions of the galls and vitriol, in a more and less dilute state, were tried next on paper. Here it was found, that the proportions which gave the greatest blackness, were not those whose colours were most durable, though in both respects there were considerable latitudes. Equal parts of the two, the quantities which the foregoing way of trial seemed to point out for the best, gave an ink of good blackness at first; but on keeping for a few weeks, and in a few days when exposed to the sun and open air, the writing changed to a yellowish brown. The mixtures, in which the vitriol exceeded the galls, underwent greater and speedier changes; more and more so, according as the excess of the vitriol was the greater. Those in which the galls exceeded the vitriol were more durable; an infusion of two parts of galls and one of vitriol made an ink which held its colour still better. When the galls were increased to five or six times the weight of the vitriol, the colour did not prove black enough, though it seemed to be rather of more durability than the others.

The writings which had changed to a brown or yellow, I washed over with an infusion of galls. Where the ink had been loaded with the ingredients, the characters became of a pretty good black; and those which had been witten with more dilute inks, became, though not black, yet sensibly more coloured than before, insomuch that many, which had grown almost undistinguishable, were now sufficiently legible. How far this infusion would serve for the recovery of decayed writings of great age, I have not had an opportunity of trying; but thus much is clear, that a distilled water of galls, recommended for this purpose in Caneparius's collection *de atramentis*, cannot answer; the astringency, or the power of giving blackness to iron, residing in such parts of the galls as do not rise in distillation.

It seems to follow, from the above experiments, that the decay of inks is owing chiefly to a deficiency of galls; that the galls are the most perishable ingredient, the quantity which gives the greatest blackness at first, being insufficient to maintain the colour; that for a durable ink, the quantity of galls cannot be much less than three times that of the vitriol; and that it cannot be much greater, without somewhat injuring the ink in point of blackness.

The proportion of liquid admits of much greater latitude than that of the vitriol and galls to one another. One ounce of vitriol, three ounces of galls, and a hundred and fifty ounces of water, made an ink, legible indeed, though greatly too pale. With a hundred ounces of water to the same quantity of galls and vitriol, the colour was still too pale. With forty and fifty ounces of water the ink was of sufficient blackness for common uses: but the fullest and blackest colour of all, was produced when the quantity of liquor was little more than enough to cover the powders; as six, eight, or ten ounces. It was expected that these small quantities of water, dissolving all the vitriol, without being able to fully extract the virtues of the galls, and thus occasioning a deficiency in the quantity of astringent matter, would have yielded a perishable ink. Nevertheless, characters written with these mixtures have preserved their colour for fifteen years, continuing still sensibly blacker than where the menstruum was in larger quantity. It appears, therefore, that though a larger portion of fluid may be tinged by the vitriol and galls of a blackness sufficient for many purposes, the using a little quantity is of advantage both to the deepness and durability of the colour; perhaps only from the liquor being in this case more loaded with the colouring matter of the ingredients, so that a greater body of colour is accumulated upon the stroke.

I next tried what alteration would result from the using of different waters, or other liquors for the menstruum. Distilled water, rain water, and hard spring water, employed in the same proportion, had, so far as could be judged, the same effects. White wine produced an ink of a deeper black colour than the waters; and with vinegar the colour was still deeper. Proof spirit extracted only a reddish brown tinge, and rectified spirit a paler brown, the vitriol not being dissoluble in these liquors. Both the spirituous tinctures sunk and spread upon the paper, that in rectified spirit more than the other: hence the addition of spirit to common ink, directed by some for the preserving it from mouldiness, or from freezing in winter, occasions generally a precipitation of part of the colour, and makes the ink sink, more or less, according to the quantity of the spirit. The coloured juices of fruits, as of privet-berries, mulberries, blackberries, used as menstruums for the galls and vitriol, made a colour rather fuller on first writing than water did, but it was less black, and soon grew dull or rusty in keeping. A decoction of logwood, used instead of water, sensibly improved both the beauty and the deepness of the black, without at all disposing it to fade.

Instead of the galls, I tried other strong astringents, as oak-bark, alder-bark, sloe-bark, sumach, tormentil root, bistort root, balaustine flowers, pomegranate peel, &c., but could not find one of equal efficacy with galls. Nor did any but the oak-bark seem to give the same species of blackness that galls did, most of the others having more or less of a greenish hue; the oak-bark itself, however, though it came nearest to the galls, made a very bad ink, and though used in eight or ten times their quantity, was far from being equal to them in effect. The saw-dust of oak-wood, which has lately been found to answer for tanning leather, as well as the bark, or rather better, and consequently to have no inconsiderable impregnation of true astringent matter, produced with vitriol a tincture somewhat different from all the astringents I have tried; the colour at first was an opake deep blue: after the liquor had stood for some days on a fresh quantity of the wood, it approached more to blackness; but still retained a very considerable blue tinge. Galls themselves give indeed a blueish colour, when the liquor is diluted so as to be transparent; but in an opake state, so far as I have observed, they exhibit no blueness.

I made trial also of the juice of sloes, which to the taste is pretty astringent, and which gives of itself, to linen, a stain of remarkable durability. By mixing the juice, whether of raw or baked sloes, with different proportions of solution of vitriol, I could not produce the least tendency to blackness, the vitriol seeming to make little alteration in the colour. Some of the mixtures, however, having been written with on paper, the characters, after standing for several days exposed to the air, changed by degrees to a full black, which appeared to be more durable than that of any of the inks made with galls; their colour having stood well in the open air from the beginning of November, till the papers were destroyed by the weather in the end of February. Writings with good common ink, exposed with them as a standard, had faded much.

As all the astringent vegetables communicate of themselves some colour to water, galls a brownish, bistort-root a dark brown, logwood a purplish, tormentil-root a reddish, pomegranate peel a greenish yellow, &c. I endeavoured to prepare a compound black from the astringents alone; hoping that this additional black in the liquor might coincide with, and heighten, that which the vitriol would produce with the direct astringent matter. Accordingly, taking a decoction of galls and logwood for the basis, I infused successively in this liquor several different astringents, till at last its colour approached pretty near to blackness. By dissolving in the dark blueish liquor a due quantity of vitriol, I obtained a good ink indeed, but not at all better, so far as could be judged, than if the decoction of galls and logwood only had been used. Perhaps the vitriol, uniting with the properly astringent parts, and thus suppressing some of the component colours of the black infusion, destroyed at once all the blackness which resulted from the combination of the colours.

Instead of the vitriol, or vitriolic solution of iron, I tried saturated solutions of the metal in other acids. With the nitrous and marine acids, the ink was too corrosive, though made as dilute as it could bear to be, consistently with a good colour; nor was the colour so true a black as that of the vitriolic ink, the marine acid inclining it to blue, and the nitrous to brownish green. Though the using of vinegar, for dissolving the vitriol, was of advantage to the colour, yet a solution of iron, made in vinegar only, gave a very bad ink. A solution of iron, made by boiling iron-filings in water with tartar, and separating the unsaturated tartar by crystallization, &c., produced with galls only a rusty brownish colour. A solution of iron in lemon juice, answered better than those in vinegar or tartar, but did not seem to come up to the vitriolic solution.

As the iron of the vitriol, and the astringent matter of the galls, unite together into a new compound, (gallate of iron) which is the tinging matter of the ink; it may be presumed that the acid, which held the iron dissolved, is extracted, at least in part, and remains loose in the liquor. Suspecting this disengaged acid to be a principal cause of the change of the inks to a rusty colour, I endeavoured to separate it, by adding to a black infusion of vitriol and galls a little quicklime; this earth having the property of of imbibing the vitriolic acid, and forming with it a selenitic compound, (sulphate of lime), which will not remain dissolved in the liquor. The ink was far from being anywise improved by this addition. A very small quantity of lime made no sensible change in the colour of the liquor;

but a larger quantity turned it reddish brown, the lime seeming to have nearly the same effect as alcaline salts have. After the writings with these mixtures had been exposed to the sun and weather about two months, those with the larger proportion of lime could not be read; and those with the smallest quantities had faded more than the ink by itself.

I then endeavoured to separate the acid in another manner. Some good ink was diluted with water, that the colouring matter might settle; and the black sediment was washed repeatedly with fresh portions of water in which some gum arabic had been dissolved. Writings with this mixture were of great durability; after hanging about four months against a south wall, they had contracted no rusty hue, though they were grown much paler than at first, and rather grey than black; perhaps even this change proceeded in part from some of the colouring matter being washed off by rain. It is the capital imperfection of mixtures of this kind, that after the colouring matter has been separated from the liquor, it cannot be again incorporated with watery fluids near so perfectly as it was before in the ink: it can only be diffused through the water in a powdery form, as the charcoal powders are, and settles from the liquor, and may be washed off from paper almost as easily.

The most effectual way of preventing any ill effects from this redundant acid seems to be by an addition of iron itself; part of which, in proportion as the iron of the vitriol is extracted, will be dissolved in its place, and thus continue both to saturate the acid, and supply one of the essential ingredients of the ink. It should seem that in this method, a much less proportion of acid, that is, a less quantity of vitriol, would suffice, than is otherwise necessary; the same acid serving to combine with the galls fresh quantities of the iron: and, in such case, keeping for a length of time, as a year or more would improve the ink.

Of this I have not yet had a full experience, but a friend informs me, that he has seen writings of more than eighty years standing, which continued of a full black colour, without any tendency to yellow or brown; that the ink was made in the common manner with vitriol and galls, and long kept with pieces of iron in the vessel. Possibly boiling for a little time might answer the same purpose as long keeping; for boiling remarkably promotes the separation of iron from vitriol, and consequently the action of the acid on the fresh iron.

Gum arabic is added to ink to give a greater consistence to the fluid, and enable it better to keep the colouring matter suspended: it contributes, perhaps, to prevent the black matter from concreting into particles large enough to settle by their weight, as well as to prevent or retard their settling after they have so concreted; for we have seen, in the foregoing part of this article, that the coalition into sensible particles is successive, and that before it happens, the black matter is in so subtile a state, that it may be considered as being in actual dissolution.

The gum appears also to be of another advantage, preventing the ink from spreading upon the paper, so that a greater quantity of the fluid, and consequently a greater body of colour, is collected on each stroke. An infusion of vitriol and galls was mixed with different proportions of common water, and with the same proportion of gum-arabic in water: all the mixtures with gum-water, written with upon paper, were at first and still continue, very manifestly deeper coloured than those which had been equally diluted with plain water. In an ink which has an over proportion of vitriol, and which when written with, soon lost its blackness and turned to a yellowish brown, I dissolved as much gum as it would bear without becoming too thick to run freely from the pen: the colour was not only deepened, but made greatly more durable; partly from the greater quantity of colour in the strokes, and partly from its being in good measure defended by the gum from the action of the air.

Gum arabic, gum seneca, and the plum and cherry-tree gums dissolve in the ink almost as easily as in pure water. But isinglass, a glue prepared from a kind of fish, would not at all mingle with it: when the isinglass was previously dissolved by itself in water, and the solution poured into an infusion of the galls only; the fish-glue immediately on mixture, began to curdle and separate. Solutions of common glue or size seemed, however, to mingle uniformly enough with the ink, no sensible coagulation or separation ensuing.

Sugar, sometimes added to inks, is much less effectual than gum, either as a coat for defending the colouring matter on the paper, or for preventing its precipitation from the liquor. It even hastens the precipitation of some part of the colour, and is accompanied with another inconvenience, that of making the ink exceedingly slow of drying. The shining hue, which the sugar communicates, is by no means sufficient to counterbalance its disadvantages; and besides, where this quality is desired, an almost equal glossiness may be obtained by means of gum.

I tried likewise to prepare an ink, in which the colouring parts should be secured by a resinous varnish. Here no water could be used, the dissolution of the resin requiring strong spirit of wine; and as this spirit does not dissolve the vitriol of iron, another preparation of the metal became necessary. Iron filings were digested in spirit of salt (muriatic acid) with a moderate heat, till the acid would dissolve no more; and the solution being set to evaporate till it became thick, it was in this state diluted with rectified spirit of wine; this preparation is the *tinctura martis in spiritu salis* of the apothecaries. I made a strong tincture of galls in spirit of wine, and dissolved in it as much gum mastic as it would take up; with this solution poured off clear, I mixed different proportions of the tincture of iron, and obtained blueish-black liquors, of a pretty good blackness, when written with, and sufficiently durable; but unfit for the common purposes of ink, on account of their spreading and sinking in the paper, and growing clotty in the pen. Part of the mastic seemed to be precipitated on mixture with the tincture of iron, as resinous bodies generally are with acids; whereas gums dissolve in acids without precipitation.

Instead of the preparation of iron called green vitriol, some have recommended the blue vitriol of copper, (sulphate of copper), and others the white vitriol of zinc, (sulphate of zinc). The white vitriol, though its principal metallic matter be zinc, generally contains also no inconsiderable quantity of iron, and in virtue of this iron it strikes a black with galls. Many blue vitriols have also a mixture of iron with the copper, and in this case they may in like manner strike a black with astringents. To common green vitriol I added different proportions of the pure vitriols both of zinc and copper; the inks from the mixtures were not equal to those made with the green vitriol only. I tried also another preparation of copper, verdegris: (acetate of copper); a small addition of this made the colour of the ink remarkably deeper on first writing, but this additional blackness did not stand, and the colour turned rusty much sooner than when no verdegris was used. The effect of this ingredient will be further considered in the next section.

In some receipts for ink the galls are directed not to be powdered, but only bruised, or broken into three or four pieces. To see if this precaution could be of any advantage, I cut some galls into four pieces each, and some into bits like large pins' heads; another parcel was reduced into pretty fine powder. Equal weights of the three were digested for a fortnight with vitriol and water in equal proportions. The ink from the large pieces was considerably paler than the other two, and that from the powdered galls was the deepest coloured.

A small wooden cask, or a stone bottle, is commonly chosen for making ink in; and the vessel is generally kept stopped. As air appears to contribute to the deepening of the colour of ink upon paper, the characters not acquiring their full blackness till a day or two after writing, it seemed probable that a free admission of air might have a like effect upon the ink in its fluid state, and consequently that a broad, shallow, open vessel, and frequent stirring, so as to expose fresh surfaces to the air, would contribute to improve the colour, and make the ink flow black from the pen. Accordingly mixtures of galls and vitriol with different proportions of water, were exposed to the air in flat stone-ware dishes, and stirred nine or ten times a day for a month. The liquors wrote blacker than those made from the same quantities of the ingredients in close vessels; but whether the difference proceeded only from part of the water having evaporated, so that the quantity of liquid was made less, or from the instrumental efficacy of the air deepening the colour, as it does that of ink written with on paper, was not fully apparent from the experiments; probably it depended upon both causes conjointly.

For obtaining an ink that should write black at once, on many occasions a very desirable point, I tried another method; similar to that by which the dyer produces expeditiously a deep black on cloth. The dyer first boils the astringent materials in water for a considerable time, and then adds the vitriol and slackens the heat, so that the liquor may never fully boil after the vitriol is put in. By this way of management, the ink was made to write of a pretty deep colour, much more so than those prepared by long-continued maceration.

It may here be proper to give a caution against the use of copper vessels for ink. Mr. Marggraf relates, that when solution of pure vitriol of iron is boiled with copper, part of the iron is precipitated in an ochery form, and the liquor becomes strongly impregnated with the copper, which in this dissolved state, as we have already seen, debases the colour of ink. I have found that copper is dissolved also by mixtures of vitriol with astringents; for having used a copper pan in experiments of dyeing black, related in the following section, the liquor, immediately after the addition of the vitriol to the astringent decoction, showed plain marks of its having taken up a portion of copper, by giving a coppery stain to an iron knife with which it was stirred. Mr. Marherr, in an ingenious inaugaral dissertation on the chemical affinities of bodies, printed at Vienna in 1762, gives an observation more decisive of the effects of a copper vessel; when the best inks were kept in a copper inkstand, so much of the copper was dissolved, that the writings became as ill coloured as if the ink had been of the worst kind. It is pretty singular that the vitriolic acid, in its separation from the iron, should dissolve a body, on which otherwise in so dilute a state, it does not seem to have any action. Leaden vessels are also observed to be corroded by ink, and debase its colour, and probably, except the materials of which ink itself is composed, all the other bodies that the vitriolic acid is capable of dissolving will be found injurious to ink.

(To be continued.)

LIST OF PATENTS FOR NEW INVENTIONS,

Which have passed the Great Seal since Oct. 11, 1827.

To Joseph Hall, and Thomas Hall his son, both of Leeds, in the county of York, braziers and brass founders, for an improvement in the making and manufacturing of metallic cocks for drawing off liquids. Dated Oct. 11, 1827.—To be specified in two months.

To Elias Carter, of the city of Exeter, in the county of Devon, upholsterer, for a new covering for the roofs of houses, and other buildings. Dated Oct. 11, 1827.—In six months.

To Joshua Horton, of West Bromwich, in the county of Stafford, boiler maker, for a new and improved method of forming and making of hollow cylinders, guns, ordnance, retorts, and various other hollow and useful articles in wrought-iron or steel, or composed of both those metals. Dated Oct. 11, 1827.—In six months.

To Goldsworthy Gurney, of Argyle-street, Hanover-square, in the county of Middlesex, surgeon, for certain improvements in locomotive engines, and other apparatus connected therewith. Dated Oct. 11, 1827.—In six months.

To James Stokes, of Cornhill, in the city of London, merchant, for certain improvements in making, boiling, burning, clarifying, or preparing raw, or Muscovado bastard sugar and molasses. Dated Oct. 11, 1827.—In six months.

To John Wright, of Princes-street, Leicester-square, in the county of Middlesex, engineer, for certain improvements in window sashes. Dated Oct. 11, 1827.—In six months.

GILL'S

TECHNOLOGICAL REPOSITORY.

XCIV.—*On Splitting, Cutting, and Polishing Diamonds, and on forming, mounting, and using Engravers', Glaziers', and Writing Diamonds, Diamond Dust, &c. By Mr.* EDMUND TURRELL, *Engraver.*

WITH A PLATE.

(*Continued from p.* 259.)

On using Diamond Dust in Seal Engraving.—I am indebted to Mr. Raphael Clint, a young artist of considerable talent in this metropolis, for the information on the important art of seal engraving, and who has also kindly permitted me to make drawings of his improved apparatus.

You have already given, in your *Technical Repository*, vol. VII., his superior method of grinding diamond dust in oil, by the employment of spherical, concave, and convex tools, made of hardened steel, instead of the steel mortar and pestle commonly used for that purpose, so that I need not enlarge further on that head.

He has likewise improved the lathe, or mill, by which the small iron wheels, tools, or laps, charged with the diamond dust, are actuated, so that it is now not only made portable, but the tremor of the table, arising from the motion of the band-wheel and treadle, is now completely removed, and thereby the constant shifting of the eye-glass, occasioned by that tremor, is completely obviated.

He now supports the band-wheel upon a separate frame, so that it has no communication with the table but by means of the slender band of cat-gut, which drives the small wheels.

In plate X., fig. 1 is a front, and fig. 2 a side elevation of his frame and table. A A is the frame, or support of the cast-iron band-wheel B, which is mounted upon the crank-axis C, the crank being two and a half inches in radius. The crank-rod D is of wood, having a hole bored through it near to its top, to fit the neck of the crank exactly, and being sawn or cleft down its middle, through the hole, so as to allow it to open and receive the neck within the hole, and it is then secured, by means of a screw passed across it, through its thickness, just below the hole, as shown by the dotted lines in fig. 2. The lower part of the crank-rod has also a hole bored through it, and a slit or mortise, made near one end of the treadle E, receives it within it; and corresponding holes being also bored through the substance of the treadle, a screwed pin is passed through these holes and the hole in the crank-rod, and thus connects them together. The other, or outer end of the treadle, has a piece of wood affixed across it, having iron pins at its ends, which turn in two holes, made in ears, secured to a square piece of board affixed to the floor of the room, so that the crank-rod and treadle are fitted and connected with the crank in such a manner as to work freely, and yet without any shake or noise. The mahogany table F, which supports the lathe or mill G, rests at its back upon a horizontal wooden bar H, which is secured across to the window frame of the room; and in front is supported, upon two other upright bars I I; these three bars are each composed of two pieces of wood, grooved in the manner of a dove-tail, and fitted tightly together, as shown in fig. 3, so as to admit of being extended or contracted in length, to suit the different situations where they may be erected. The mahogany table also constitutes the front of the box, which is formed by it and the covered sides of the frame A A, in travelling; and it carries the female halves of the two hinges J J, which are hung upon the pins in the other halves K K, affixed to the side of the front of the frame. When, however, the table is laid horizontally, as shown in the two figures, the holes in the half hinges J J receive into them other pins, which are affixed to the plates L L, and secured to the upper ends of the bars I I, so as to retain them in their places firmly, and as shown in fig. 1. When the three bars are not in use, they can be contracted or shortened sufficiently to admit of their being packed up, and carried within the box. The upper part of the box, and the mahogany table, have both longitudinal slits made in them, to permit the band from the wheel to pass to the pulley on the lathe mandrel; and which slides in travelling are closed by pieces of wood made to fit them, and secured inside the box by turn-buckles.

Mr. Clint prefers to have his table placed at such a height, as to permit him to stand at his work, in preference to sitting; which latter posture, he states, is apt to induce painful disorders, which the standing posture is entirely free from. His elbows rest, and are supported upon two circular leather cushions, M M, of about nine inches in diameter, and filled with bran; and his hands are thus sufficiently steadied for their nice and delicate work.

The mandrel of his lathe is supported on a neat cast-iron stand N, which is shown on a scale of one-half its real size in fig. 3, which is a side elevation of its upper part; and in fig. 4, a plan and section of its top. This stand is mounted upon a wedge-shaped piece of wood, affixed underneath it upon the table, so as to throw its upper part forwards towards the artist, and as seen in fig. 2. The mandrel O, figs. 3 and 4, is formed of steel, hardened and tempered; its front end is slightly tapered, and has a shoulder upon it, and its back end is made cylindrical, and runs in a cylindrical hole formed in the end of a steel screw, P, likewise hardened and tempered, and which is fitted into a screwed hole made in the stand N, and is secured in its exact position by the lock-bur, Q. The bottom of the cylindrical hole in the screw P is made flat; and the end of the mandrel which acts against it is *slightly rounded,* or made *convex,* so that the central part of it, which, as you have so often inculcated, should be made to touch, or come into bearing with the flat end of the hole, in order to lessen the friction, is exactly formed in that manner, and I believe, in consequence of your having suggested that plan to Mr. Clint upwards of four years since; and the consequence has been, that, so far from any *friction* having been induced thereby, *it has been very greatly lessened;* and the ends of the hole and the mandrel are both *finely polished in their centres,* the very effect you proposed in this judicious arrangement, and which ought consequently to be adopted in every other similar case. The front, or taper end of the mandrel, runs in a cleft *pewter collar,* in a similar manner with the mandrels of the lathes used by button burnishers, and both mandrels run with great velocity in use, the pewter collars not being subject to heating, as steel or brass ones do. This collar has likewise been in use for four years, and is yet perfect, great care, of course, having been taken to avoid the introduction of any hard gritty matters, which would lodge themselves in the pewter, and abrade the mandrel. This pewter collar was cast upon the mandrel itself in its place, each side of the front end of the stand N, having been previously closed by plates of tinned iron, with holes in them to fit and support the mandrel in its place in the stand. The collar was afterwards sawn across horizontally, to divide it into two parts as usual; and it is retained in its place in the stand by means of the two angular parts, or cheeks, of the front of the stand, the whole being bound down in their places by a covering plate and two screws. A third screw also passing through a hole in the middle of the plate, presses down the uppermost half of the pewter collar, to make it fit the mandrel accurately in case of wear.

The mandrel O has a gently tapering or conical hole, R, fig. 4, made through it, and a cross hole, or mortise, S, made at the smaller end of the conical hole, as shown in figs. 3 and 4. The tapering hole R is made to receive within it the conical or tapering parts of the stems of the tools, which carry the diamond dust. One of these tools, of its full size, is shown in fig. 5, it being two inches in length in the conical part, one quarter of an inch in diameter at its smallest end, and a quarter and a sixteenth of an inch diameter at its larger end; this difference of a sixteenth of an inch, in the diameters of the two ends, being sufficient to ensure its sticking sufficiently fast in the tapering hole in the mandrel, so as not to come out in use, and yet allow it to be pushed out by the application of a wedge to the inner end of it, which projects into the mortise or cross slit made in the mandrel for that purpose. These cones are all cast in a brass mould, in a composition of lead, hardened a little by the addition of regulus of antimony, or type metal; and as the construction of this mould displays considerable ingenuity, and is of the highest importance to the success of the art, I shall avail myself of the permission given me by Mr. Clint to describe it. In fig. 6, T is a wooden block, serving to support and receive, within a circular hole made in its centre, a pair of brass jaws, U U, which are formed of two similar parts, fitted together by four steady-pins affixed in the one half, and entering into corresponding holes made in the other half, as shown in fig. 7. These figures are drawn upon a scale of one half their real size. Into these jaws, U U, the outer stems or shanks of the tools V, figs. 5 and 6, are to be fitted by filing; or, if very slender, by wrapping paper around them; and the jaws are then to be placed upright in the hole made in the block T to receive them, the stem of the tool being also held upright in the jaws. The inner square, jagged and tapering parts of the stems of the tools, are then inclosed within the principal part of the mould W, fig. 6, which is made exactly to correspond in length and size with the tapering hole in the mandrel, and has a stem and wooden handle X fitted to it. The lower part of the mould has a neck, which fits exactly into a recess made in the upper parts of the jaws, and the mould being held in such a position as that the pointed end of the stem of the tool shall be placed in the centre of the hole in the mould, the melted metal is then to be poured into it with a small iron ladle with a lip to it, or with a tobacco pipe, which conveys the metal from the larger ladle in which it is melted, and also serves as a measure for it. When the metal is set, the cast is to be removed from the mould by the help of a cylindrical iron rod, of the exact diameter of the smaller end of the mould, and upon which the mould is to be supported, and gently struck, until it has forced the cast out. It will be seen that the cast is made entirely in the part W of the mould, the extraneous parts which may project below it being afterwards removed by filing, &c. Fig. 8 is a plan of the lower or wider end of the mould W, in which will be seen an angular gap, Y, filed in its mouth. This gap causes a small projecting angular part to be cast upon the larger end of the cone, as shown at Z, in fig. 5, and which fits into another angular gap, which is made in the inside of the mandrel O. This projection serves to prevent the tools from turning loose in the mandrel, and also ensures their being constantly placed in the same relative situation within it, a thing of the utmost consequence to be attended to.

The tools are all made of *the softest iron*, either of horse-nail stubs, welded together by the gun-barrel forgers on purpose for this use, or else of iron wire, cut into proper lengths, and forged tapering, and then bundled up together many at a time, and placed at the back of a kitchen fire on lighting it in the morning, and again withdrawing them the next morning. In this way they will have been exposed to the heat of the fire all day, and have gradually cooled with it, so as to be perfectly *annealed*, and rendered fit for use. They are turned in their places in the lathe mandrel by proper tools, supported upon a rest, the main bar of which is passed through a hole made to fit it in the lathe stand, as shown by the dotted lines in fig. 3; and it is mounted in the usual manner of the Lancashire lathes, on a sliding cross-bar, and adjusted by screws, the main bar of it being screwed in the stand by the binding-screw *a*, shown in fig. 3. The general forms of the tools will be understood from the one shown of its full size in fig. 9, it being one of the largest used: V is part of the stem, upon the outer end of which the tool *b* is screwed. It will be seen that the periphery of this tool is conically shaped, or smaller in front than behind. The part used is that marked *c d*, the edges *e* and *f* being rounded off; this shape is given to it, owing to the necessity of holding the stone at an angle in cutting it, in order to avoid encountering the stem of the tool. The tools, figs. 10 and 11, are nearly shaped like fig. 9, but are smaller, and many more still smaller are required. Fig. 12 is a tool with a double rim, the use of which is to shadow the ground of a shield, &c., with equi-distant parallel lines, the tool marking a second line while cutting the former one. These smaller tools are not, however, affixed upon the ends of the stems, as that shown in fig. 9 is, but are formed of one piece with them, by the turning-tools. The stones to be cut are preferably red or white cornelian, shaped by the lapidary. The polish is, however, first removed from their faces by means of emery and water, applied upon a flat pewter plate, and upon which the stone is rubbed, after having been cemented to a proper wooden handle, as shown in fig. 13. The outlines of the design are then drawn upon it by the help of a pointed brass wire, which admirably answers this purpose. It is then ready for cutting. In order to this, the engraver applies a little of the ground diamond dust and oil, taken off the surfaces of the steel grinding tools above-mentioned, by means of a scoop formed of quill, to the periphery of the tool, which imbeds itself firmly in the soft iron of which it is formed. The diamond dust has been ground up with olive oil, but the tool is continually lubricated during its operation with a vegetable empyreumatic oil, commonly called *oil of bricks*, and which is prepared by the chemists for this purpose, by soaking pieces of red-hot bricks in oil, so as to cause them to imbibe it, and then subjecting them to the process of distillation. This oil is contained in a small conical vessel, made of tinned sheet iron, which is soldered into the upper end of another cone, as shown in fig. 14, as a support to it; and, indeed, with a view to give it more stability, Mr. Clint has had one of them placed within a copper hoop, and filled up both externally and internally with melted lead. It is a fact, that the delicate work of seal engraving is in reality performed more by *feeling* than seeing, the sight being hindered by the tool itself, and by the escape of the abraded particles of the stone, and the oil flowing off from the tool, and forming an opaque spot, through which the sight cannot penetrate. The effect of the work can therefore only be judged of by continually taking raised impressions from it on a small mass of bees-wax, mixed with ivory-black softened and wetted, and applied to the face of the stone. The handle to which the stone is cemented is held in the right hand, supported upon the table; and the stone is farther guided and steadied by the help of the left hand, the palm of which is lodged upon a convex plate of metal, with which the top of the lathe is covered, as shown in fig. 1, in dotted lines, and thus the entire command over the stone, and the power of varying its position during the work, is acquired.

The sight of the artist is assisted by means of a convex lens, of an inch and a half in focus, which is mounted in a similar manner to the hand-glass used by watch-makers, engravers, &c. This lens is held in a loop made at the end of an iron wire, which is passed through a horizontal hole, made in a wooden ball or sphere of three inches in diameter, and which has also another hole bored through its centre at right angles to the former one, which is fitted upon another wire or stem, affixed into a heavy metal foot or basis, having three nails or screws on its flat underside, to ensure its steadiness. The wires are bound fast in the holes in the ball by binding screws. This apparatus is shown in figs. 1 and 2, at *g*; in fig. 14, which is a plan of it; and in fig. 15, which represents its underside.

It is obviously quite impossible to give any instructions here as to the mode of operating in seal-engraving, which can only be acquired by a long course of practice, aided by the skill of the instructor, and of the pupil himself, my aim being merely to describe the apparatus employed therein.

When the work is performed, it is of course necessary to restore its polish to the face of the stone. This is ordinarily performed by means of a flat lap or mill of pewter, mounted upon an upright axis in a separate frame, and driven by a band from a band-wheel. But Mr. Clint has provided one, affixed on his portable frame, and actuated by the same band-wheel which drives his tools. In figs. 1 and 2, this lap is shown at *h*, its axis lodging in a hole, and resting upon the upper end of an adjusting screw, inserted into a cross-bar, *i*, of the frame A A. Its upper end is supported by a stud, affixed in an iron arm or bracket *j*, which is securely affixed by screws upon the top of the frame, the stud entering into a hole made in the top of the axis. A band passes from the wheel B under one of two brass pulleys, *k*, fig. 2, mounted in a proper frame, then over the pulley to the *whorl* or pulley upon the axis of the cap, which it partly surrounds, and then proceeds to the top of the other pulley at *k*, from whence it passes down to the periphery of the band-wheel, and it is thus conveniently actuated. The polishing is effected by means of rotten stone and water, applied upon the flat face of the lap, the rotten stone being carefully freed from any coarse or gritty particles with which it is ordinarily mixed, by picking them out. And, in order to prevent the splashing of the rotten stone and water, the lap is surrounded by a tin box, the lower part of which has a hole made in its centre to allow the axis of the lap to pass through, previous to fitting the pulley upon it; and its lid has a slit made in its top and side, and extending to its centre, to allow it to pass by the spindle or axis in shutting up the box, and which slit is finally closed by means of a sliding plate of tin, which is guided by grooves, formed in the lid to receive it. Fig. 16 is an elevation of this box, and fig. 17 a top view of it.

The cutting tools are carried with great velocity, they making twenty revolutions for one of the band-wheel. The best diamonds for this purpose are those which, being black and rough, are rejected by the jewellers; but Mr. Clint states that he once had one which was rejected for a different cause, namely, being *so very hard* that they could not find another capable of cutting it.

Glass cannot be cut in this way, as the glass causes the particles of diamond dust to cut the tools. Glass is cut by means of emery, applied upon *copper* tools.

Animal forms, and graceful curves, are most easily executed in seal-engraving upon stones, owing to the tools being circular. In die-seal engraving upon steel, on the contrary, flat and square forms are readiest effected, they being done by means of punches and chisels; and hence the superior beauty of engravings upon stone. The mode of operation also enables the artist to execute much more minute subjects than can be produced in other methods of working.

(To be continued.)

XCV.—*On a Superior Method of Lubricating or Oiling the Pivots and Bearings of Mill Work and other Machinery. By Mr.* JOHN BARTON, *Engineer, of Seward-street, Goswell-street, London.*

WITH A FIGURE.

IN plate X, fig. 18 represents a section of a metal vessel, closed by a moveable lid, and having a pipe passing through its bottom, and ascending near to its top. Into this vessel the oil is put, wherewith to lubricate the bearings; the lower end of the pipe being fitted into a hole made to receive it in the uppermost of the two brasses, within which the neck or pivot turns.

A skein or a few threads, according to circumstances, of woollen yarn, is placed in the vessel amongst the oil, and its other ends are brought within the pipe, hanging down within it, below the bottom of the oil vessel, sufficiently to cause the oil to drop slowly, by the capillary action of the threads, and also in the manner of a syphon; and thus continue to supply oil to the bearings, so long as any remains in the vessel.

We are glad to find that this excellent mode is already adopted in several large establishments, and that Mr. Barton has also lately received orders for more of the vessels, for the machinery in the royal dockyard, at Portsea, Hants; and, indeed, they ought to be universally adopted.

XCVI.—*On an improved Wind Furnace. By the* EDITOR.

WITH A FIGURE.

THOSE persons who have occasion to employ wind furnaces must have experienced the inconvenience of having frequently to rebuild or line them with fire bricks in their insides; this inconvenience is now obviated in the following manner:—

The furnace is enclosed within a cast iron cylinder of half an inch in thickness, and of a proper length, according to the scale of the furnace; in the example shown in the section, fig. 19, of plate X, it is two feet and a half in length, and two feet and a half in diameter internally. In its top and bottom circular holes are formed, each one foot in diameter, and its inside is coated with a lining of glass-cutters' or grinders' slush, being a mixture of sand and glass, nine inches in thickness; the holes in the top and bottom serving as guides for the lining, by applying a straight bar of wood to them, and causing the lining to touch it all round. A vent hole to the chimney or stack of four inches wide, and three high, is also to be provided near its top, and a covering plate with handles fitted to it. It may be supported below on brickwork to form an ash pit, and be furnished with wrought iron bars as usual.

XCVII.—*On Tortoiseshell, and the mode of Soldering and Working it for various purposes**.

WITH A FIGURE.

TORTOISESHELL is the shell or covering of the tortoise or turtle, an amphibious animal. Of the tortoise there are several species; some of them, however, are without a shell. The *testudo imbricata* of Linnæus, a sea turtle, found both in Asia and in America, is much sought after, not for its flesh, which, though always agreeable to the palate, is sometimes unwholesome, but for its scales or covering, from which is made a variety of useful and ornamental articles of great beauty.

There are in this shell three distinct colours, a light yellow, a light brown, and a darker, though transparent brown, almost black. Either one or two of these are, in general, the prevailing colours; they are, however, commonly found in combination. Tortoiseshell is usually transparent, hard, and easily broken. Although in its texture it bears a strong resemblance to horn, it is much less tenacious than this substance, in consequence of its fibres being united with a smaller proportion of oily matter. Tortoiseshell is, nevertheless, very flexible, and by the aid of fire, or of boiling water, acquires a considerable degree of pliability; but, after being suffered to cool, it retains the form given to it when heated, and becomes as brittle as at first.

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* From the *Franklin Journal*, and translated from the *Dictionnaire Technologique*.

Tortoiseshell possesses the singular property of becoming perfectly united or soldered, without the use of any other agent whatsoever.

The surface of the shells is generally protuberant and uneven; it is necessary, therefore, in the first place, to flatten them: for this purpose they are steeped in boiling water a sufficient time to soften them; they are then placed in a press, one upon another, with flat plates of iron or brass, two lines in thickness, interposed between each shell; these plates must be made warm previously, and the press is to be screwed down a little at a time, and the whole suffered to cool completely before removing them.

The shell may also be either straitened or bent by means of fire: for this purpose it must be held before the flame of a clear fire, moving it about continually, otherwise it will be scorched, and thus rendered entirely useless. There is, however, no risk whatever in allowing it to remain in boiling water until it is softened; this method, therefore, ought always to be preferred: besides, fire always affects the colour in some degree, which is never the case with boiling water.

The method of Moulding Tortoiseshell.—The mould, whatever be its form, is always composed of two parts, similar to those used for casting pewter spoons. A small iron press of sufficient size to contain the mould will also be required.

The shell, after having been prepared in the way before directed, is to be brought to a proper thickness, either by means of a rasp, a toothed plane, or a coarse float; the shell is then to be softened in boiling water, and the mould having been previously warmed, the piece is to be put in its proper place in it, and the projecting pins on one half of the mould be made to enter the corresponding holes in the other half; the mould is then to be put into the press, and the screw forced down, until a slight resistance is experienced; the whole is then to be put into boiling water, when the screw is turned, by degrees, until the two parts of the mould exactly touch. When this is accomplished the press is to be taken out of the water and allowed to cool. The mould is then placed in cold water for a quarter of an hour, before taking out the shell, and which will afterwards retain the form given to it.

To Solder Tortoiseshell.—To solder two pieces of shell together, the two edges which are to be joined must be filed away to their edges, or bevelled, or chamfered, taking care that the same taper or inclination be given to both, and that they perfectly fit each other. They are then to be placed one upon the other, and when the joint is well fitted, a strip of paper is to be wrapped firmly round them two or three times doubled; the whole must then be secured by tying a piece of thread around them. A pair of pincers, resembling small smiths' tongs, or the pinching-irons used by hair-dressers, must be heated, the mouth of which must be of sufficient length to embrace the whole joint: these are to be squeezed together until the shell will bend by its own weight, or by the application of a small force with the finger. The tongs are then to be removed, and when cooled the piece will be found to be perfectly soldered. Care must be taken that the tongs be not too much heated, otherwise, instead of soldering, they will burn the shell: to prevent this, they must be tried by pinching white papers between them; when they are of such a temperature as to scorch it very slightly they are then fit for use.

The construction of the mouth of the tongs is a point of great moment, and one to which sufficient attention has not been given; in consequence of this the operation often fails, or is very imperfectly performed. The two jaws ought to preserve a parallel direction, as they approach each other in squeezing the juncture of the shell; but, as as they ordinarily move upon a pivot, it necessarily follows that they are adapted only to an article of the precise thickness for which they were constructed. The writer was consulted by a workman in this line who was anxious to obviate this difficulty, and a plan was suggested which was found to answer perfectly, and which has been kept secret by the individual to whom it was communicated; but as he has no claim to the invention, and its utility has been proved, the present is embraced as a suitable opportunity of making it public.

In plate X., fig. 20 shows the form in which the instrument may be made. The length of the arms A D, A B, are proportioned to that of the longest joints upon which they are to be used. The upper face of the lower jaw, G B, is always in one plane, and it is formed of the same piece with the branch H A, the other arm of the lever, and which carries the loop H. The second lever, I A C E F D, is formed of two separate pieces, I A E is one, and F D the other. This last is hung to a joint, made in a fork, formed at the end of the arm C F, and plays freely on the pin E, so that when the four fingers are placed in the loop I, and the thumb in H, on closing the jaws, the surface K D of the upper jaw applies itself accurately to the surface G B of the lower one. It results from this contrivance, that, whatever may be the thickness of the piece submitted to pressure between the jaws, it will be equally pressed by the jaws over all parts of its surface. And even should the piece be wedge-shaped, or thinner on one edge than on the other, yet it will be equally pressed all over, the jaws accommodating themselves to the inequality in its thickness.

Care must be taken that the moveable piece F be as large and thick as the fixed part of the mouth G B, in order that both may retain the same heat, and the one not cool before the other.

Sometimes the shell is soldered by means of boiling water, in which case the two pieces to be joined must be so disposed that they may be put into the press with the joint a little overlapping, and enclosed between two pieces of metal: the screw is to be sufficiently tightened to retain the pieces in their proper situations, when the whole is to be placed in boiling water, and as the shell softens the screw is to be forced down, and when cold the union will be complete.

In whatever way the soldering may be effected, great care must be taken that the two sides of the joint be perfectly adapted to each other, and they must be left clean from the tool, as the most minute portion of grease, or dirt of any kind, will defeat the operation. They must not be touched by the fingers, nor ought even the breath to be directed upon them.

When pieces are to be soldered, such parts ought to be joined as agree in colour, so that their colours and their shades may be as alike as possible; as thereby the place of the joint will be hidden, or rendered difficult of discovery.

On making Articles in Melted Tortoiseshell.—Articles made of tortoiseshell melted have been known in commerce for a number of years, particularly very beautiful snuff-boxes, which, however, are very rarely transparent. The method of making these was long kept secret. A very skilful workman in this department, who is now established in Brazil, communicated to the writer his mode of working, and also repeatedly operated in his presence without enjoining secrecy.

This workman collected all the refuse of the workers in tortoiseshell, such as the small bits, the raspings, the turnings, the scrapings, &c., which he obtained for a trifling sum; of these he made round snuff boxes in the following manner.

He had moulds made of bronze in two pieces, the one entering the other, like a nest of weights; the lower half was fixed in an iron frame, which also carried a screw in its upper part, which pressed upon the upper half of the mould. One pair of moulds served for the bottom and another pair for the top of each box, and of these he had fifty different kinds.

Over a furnace constructed on purpose was placed a boiler, in the form of a parellelogram, which would contain twenty-four moulds, three in width, and eight in length.

The fragments of shell were all broken into small pieces, of which he took a certain quantity by weight, his great practice having taught him the exact quantity necessary to form either the bottom or the top, allowing for that was to be taken off in turning and adjusting his boxes. This quautity cannot be told, but will soon be ascertained by trial and experience.

Having put the proper quantity into each mould of the fragments or raspings, &c., he placed upon it the counter-mould, and forced it down by the screw of the press; when all the twenty-four moulds were thus prepared, he arranged them in proper order in the boiler, the water in which was previously heated very hot. When the water boiled, he forced down the screw of the first mould, then that of the second, and in like manner of the whole twenty-four; he then recommenced and proceeded in the same way, keeping the water the whole time in a state of ebullition, until the counter-mould could be forced in no further, which showed that the space between the moulds was entirely filled with the melted shell.

The boiling water was always preserved at the same height in the boiler; the quantity which evaporated being replaced by a small stream of boiling water, which was supplied from a higher boiler, kept in constant ebullition by a fire in the same furnace. The heads of the screws of the presses stood above the surface of the water, in order that they might be easily turned by a proper key or wrench. Each of the twenty-four presses were wedged or braced firmly in the boiler, so as not to be moved when its screw was forced down.

It should have been stated, that a deep groove was made around the counter-mould, of the bottom of the box, around which a hoop or circle of handsome tortoiseshell was placed, which served to form the transparent rim of the box. This piece was left rough on its outside, which caused it to become more perfectly soldered to the rest of the shell, so as to form with it one entire piece.

When the whole was cold, the moulds were taken apart, and the boxes with their covers removed: upon the exterior surfaces of these were formed designs in relief, figures, historical subjects, or, in fine, whatever device had been engraved upon the moulds; and nothing more was necessary than to put the boxes into the lathe in order to fit them together, and to smooth and polish them interiorly and exteriorly, when they became fit for sale.

When it is wished to cover with tortoiseshell articles of value, such as ornamental cabinet work, the shell is not applied immediately upon the wood, but after dressing it and bringing it to a proper thickness, the under side of it is covered with a black or red coat of lamp-black or vermillion, mixed and thoroughly incorporated with fish-glue; and upon this coat of colour paper is immediately applied, and will adhere firmly. This serves to give a good effect to the appearance of the shell, and prevents the glue or the grain of the wood from appearing through it. The whole is then glued upon the wood in the manner of veneer. L.

We have repeatedly performed (says the Editor of the *Franklin Journal*) the process of soldering tortoiseshell, and have always done it without any difficulty, by means of boiling water. The shell to be soldered should be reduced as little as possible in thickness, as in forcing the two ends together a depression or groove is produced on each side of the joint, which, if the shell be thin, cannot be completely turned or filed out. The only purpose for which we have undertaken this was to form rims for snuff-boxes; but the most perfect and beautiful specimens which we have seen, have been walking sticks manufactured in France and in India. These were formed of one perfect tube, which of course consisted of strips soldered together and afterwards bent round, and united their whole length; this was done so neatly, that the place of juncture could only be discovered by narrowly inspecting the occasional abrupt terminations of the coloured clouds in the shell.

We think it probable that a less degree of pressure may answer with the heated iron than with the boiling water, in which case thinner shell may be united; but of this we cannot speak from experience.

XCVIII.—*On the Manufacture of Kirschwasser*[*].

THIS liqueur, which is known in France by the name of kirsch, and in Germany by that of kirschwasser, is, as no one is ignorant, extracted from cherries. The peasants in Switzerland and in Germany distil this liqueur only at that time of the year when they are gathered, and prepare a liqueur of an acid taste, caustic, and injurious to the health. We only make known their vicious process, with a view the better to appreciate the value of a superior mode of operating.

The kind of cherries which they generally employ are of a harsh flavour, and the fruit is black when it is well ripened, having a long reddish stalk, and a stone, which is very large in proportion to the size of the fruit. When the fruit is ripe, in order to save the trouble of gathering them by hand one by one, and which is indispensable when the cherries have attained the necessary degree of ripeness, the peasants beat them down with poles, and they are afterwards collected by children, who throw them pell-mell into tubs. There are thus mixed, in one heap, unripe cherries with those which are rotten. They do not separate these, but crush the whole, sometimes with their hands, and sometimes by the help of a small wooden board, in small baskets of osier, made rather concave, and placed over the vessels which receive the juice. They lastly bruise the marc or refuse, with the intention to break the stones and expose the kernels, and throw it, thus prepared, into the juice, in order that in the vinous fermentation it may contract that agreeable perfume which distinguishes it. This perfume is produced from the kernels of the cherries.

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[*] From the *Dictionnaire Technologique.*

When the fermentation is completed, they throw the whole, both refuse and liqueur, into an alembic, and distil it without taking any care or pains. It is important to describe the apparatus employed, in order to make known the combination, by which the product is rendered so bad. We extract the description of it from an excellent memoir of Ami Argand's, who was present at the operation, and whose testimony is fully entitled to credit.

"After the harvest, they brought down from the garret a small and ill-shaped alembic, which had been covered with verdigris for a year, and merely contented themselves with washing it in boiling water held in a tub. They then placed it in the chimney, upon a tripod, over a naked fire. The cherries, left to ferment in a common tub, open at top, but little or at most ill-covered, consequently become acid, and even mouldy at top. These, together with the wine, were all thrown into the alembic, at the bottom of which had been previously placed a handful of straw. The head of the still was then luted with a little mud; and instead of a worm, they employed a short pipe, which passed through a bush, wetted with water." Such was the apparatus.

The process, as we have seen, was the worst they could have adopted. The liqueur had not only a bad taste, but was injurious to the animal economy. The bad taste was indeed qualified by the flavour of almonds, derived from the kernels of the cherries, which predominated, and thus prevented its empyreumatic flavour from being so much perceived. This liqueur is, nevertheless, become fashionable, and forms an important object in commerce.

Other persons manufacture the kirsch, without even employing cherries at all; they infuse for a fortnight the leaves of the peach-tree in the ill-flavoured brandy distilled from the marc of grapes and the dregs, or from apples, and then distil it in a bad apparatus. The peach leaves give it the almond flavour; and often, when the empyreumatic taste peculiar to bad brandy is not sufficiently concealed by this means, they employ the leaves of the cherry-laurel, which contains a principle (the Prussic acid) exceedingly deleterious! Is it not a shame to sell a liqueur so poisonous for the true kirsch, which is known to be manufactured in the Black Forest, and from whence we obtain the most perfect liqueur?

The inhabitants of the Black Forest manufacture this liqueur with all the care that art, guided by science, can employ, and with success. This is their process:—

When the cherries are for the most part ripe, they collect them one by one with the hands, and reject all those which are over-ripe; in this state they do not take those cherries which have separated from the stalks, but only those which remain on the branches; they also reject all those which have become rotten.

After having thus collected a large quantity, they commence their operations; they crush the fruit, previously freed from the stalks, in a wicker basket, made a little concave, and placed over a tub, which is a little smaller than the basket; the expressed juice falls within it. They weigh the marc, and bruise a fourth part only of it, which with the juice they throw into a cask, cover it, and let it ferment.

When the fermentation is perfected, they uncover the cask, and opening a cock at the bottom of it, receive the clear liquor in a basin, and instantly convey it to the alembic, which is formed in the well-known manner, but is heated by steam. Those manufacturers, indeed, who have the highest reputation, distil in alembics made of tin. They thus take all the precautions necessary to obtain a lipueur of a good flavour, and which the connoisseurs can readily distinguish from all others which are sold under the same name.

It is important not to bruise too large a quantity of the kernels. We know that bitter almonds contain a large quantity of the hydro-cyanic (prussic) acid, which, in a state of purity, is the most violent poison known. For this reason, we think that when the liqueur contains too much of it, it must rather be prejudicial to those who drink it. The bitter taste of the almond is agreeable, taken in a small quantity; but when the dose is too great, the animal economy is grievously affected. This is the reason why the good manufacturers of this liqueur only bruise a fourth part of the marc, and would not employ a fourth part of that weight of almonds, but only an eighth.

It is certain that when the kirsch is well made, it has no acrid or empyreumatic flavour; and when old, it is not only pleasant to drink, but it possesses also the valuable property of helping the digestion, and warming the stomach by its spirit. Physicians recommend this liqueur in indigestion, and as a preservative against certain maladies. Experiments, a thousand times repeated, have proved that fruits are preserved in brandy. They are decomposed and mollified in the kirsch.

The valuable qualities which it is known this liqueur possesses beyond contradiction, increases the interest which every one must feel in seeing that it is prepared with every possible care, not only to free it from the ill taste which it is well known it too often possesses, but also, and which is more important, from the deleterious principle which it contains, when not carefully made. L.

XCIX.—*On the Preparation of Enamel Colours**.

The enamel colours are composed of glass, and are in general opaque; the colours being always produced from the union of various metallic oxides, to which are added certain fixed and fusible salts, such as the borates, the fluates, and the phosphates.

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* From the *Dictionnaire Technologique.*

The simple enamel, and that which serves as the basis of most of the others, is obtained by calcining a mixture of lead and tin, in proportions varying from fifteen to fifty parts of tin, to one hundred of lead. The medium proportion is found convenient for most enamels; and the alloy is so combustible, that the calcination is effected with great facility in a cast-iron vessel, at a temperature not exceeding a cherry red, if the proportion of tin is not too great. The oxide is removed from the sides of the vessel as fast as it is formed, and thrown back again to the centre; more of the alloy is added from time to time, and the additions continued, until the whole quantity is employed which is to be calcined. The greatest care should be taken to remove the metallic particles from the oxide, as they give it an hardness; and, for the same reason, the calcination should be effected with the least heat possible, otherwise the oxide forms a sort of frit, which hinders its divisibility. When the calcination is finished, the whole is suffered to cool, and the oxide is ground in proper mills, with water, and afterwards the oxided parts are separated by *levigation,* or washing over, from those which have not undergone that change. It is in this state of purity, and great divisibility, that this species of putty, termed in French *calcine,* is mixed with a fusible sand, an alcaline matter, or marine salt. The proportions commonly used are four parts of sand, one of marine salt (muriate of soda), and four of *calcine.* Chaptal states that he obtained a most beautiful product from a composition formed of one hundred parts of *calcine,* made from a mixture of equal parts of tin and lead, one hundred parts of calcined flints, and two-hundred parts of the sub-carbonate of pure potash. The mixture was made in a crucible, supported either on a bed of sand, of lime slaked in the air, or on ashes, and placed in a furnace employed to bake stone-ware. The mass had undergone a semi-vitrification; but portions of the upper part were entirely fused. This is the kind of frit which serves, as we have before stated, as the basis of all the enamels; but we must vary the proportions of the ingredients, as we would obtain enamels more fusible, more opaque, or whiter. The first of these properties depends upon the quantity of sand or flux; but the others are derived from the tin.

The marine salt, which is employed as a flux, may be replaced either by salt of tartar, potash, or soda; but all of these fluxes give particular qualities to the enamels.

Most of the authors who have written on the making of enamels, have insisted on the necessity of carefully selecting the sand, which enters into the composition of the frit, and have affirmed that the most pure was not that which was the fittest. Clouet thought it should contain at least one part of talc to three of quartzose sand; but the enamel which he obtained therefrom was not completely vitrified, and he found points upon its surface, which rendered it rough: it is also recommended in many of the old treatises, to fuse the calcined and pulverized flints by the aid of tartar, or some other flux. It appears, therefore, that the talc is of no use in increasing the fusibility of the silex, and that we can only remove that defect by increasing the quantity of the flux. In all cases we must carefully guard against the introduction of any metallic calxes, and particularly those of iron or manganese, which are the most frequently met with, and which always injure the whiteness of the frit.

In a country where chemistry is so universally and successfully cultivated as in France, it is surprising that a branch of the arts, which so peculiarly belongs to this science, should not have attracted the particular attention of some chemist, capable of establishing it on positive data. The manufacture of enamels amongst us remains yet in its infancy, and we are indebted to foreigners for the greater part of these products. We have added but little in our time to the means employed by the ancients. They were much occupied formerly in this species of manufacture; and we see, by the specimens which we find amongst the collections of antiquities, and in ancient monuments, that in those remote times they made enamels, of the composition of which, and of their mode of forming them, we are now ignorant. Then, as at present, every artist made a mystery of the means by which he succeeded best, and whole crouds of processes, no doubt, perished with their inventors. Another cause has also powerfully contributed to this sort of defection, this is, that amongst the great number of receipts which have been published upon the composition of enamels, there are many, in which are mentioned substances which can scarcely be procured, others have changed their denominations, and we know not what the ancients intended by the names they have given to them, either because these substances are no longer found in commerce, or are no longer of the same kind as formerly. Thus, at any rate, we now find it impossible to obtain satisfactory results.

What we have now to say, proves how desirable it would be to recommence this work on a new basis, and turn to profit all the data acquired; and to use for the composition of the enamels all the principal materials in their purest state. We should thus possess fixed points, and have only to guard against the effects of temperature, and our success would become infinitely more facile.

Respecting the superiority of foreigners, and especially of the Venetians, in this respect, we may observe, and give it its due value, that they are also in possession of the means of furnishing enamels with certainty, and we may attribute the cause of this to be, that the quantity consumed by them is so considerable, as to make it worth while to erect large establishments, and to keep assortments of every variety of specimen; whereas in France, where there is but little done in mosaic works, and where the employment of enamel in jewellery is out of fashion, no manufacturer is tempted to embark his property in the making of enamels, for which the demand is so rare; and we may add, with truth, that in general the Venetians are not only more certain than our artists, to obtain at their pleasure every variety of tint, but they voluntarily take all those which are produced at hazard; because thus they obtain a series of every shade which is desirable for their purpose.

Enamels are either transparent or opaque, that is to say, that in the one case their elements have all experienced an equal degree of liquefaction or fusion, so as to become crystal; whereas in the other, some of their elements have resisted the action of the heat, and their molecules have preserved an aggregation, which opposes the free transmission of light. This effect is especially produced by the oxide of tin, as we shall show when treating on white enamel.

Before proceeding to describe the principal processes employed in obtaining the different enamels, we shall make a few general observations, and remark in commencing, that with respect to the first material, which we have named *calcine*, that we are not to believe, as pretended by some authors, that we may take indifferently, in order to form this fundamental product, the result of the simultaneous calcination of lead and tin, or those two oxides prepared separately. It is a great mistake to suppose, that the frits which are obtained in ordinary substances by each of these methods are the same. It is thought, nevertheless, that if we grind on a porphyry for a long time the mixture of the two oxides, and afterwards pass them through a sieve, that we shall equally succeed in obtaining an homogenous product; but notwithstanding the performing of these minute, tedious, and expensive processes, to which it is impossible to confine oneself in the arts, it constantly happens that these oxides are unequally distributed in the mass, and consequently that some parts are more fusible than others, so that the enamel produced is necessarily gravelly.

We may easily foresee that we must modify thc composition of the frit, agreeably to the kind of enamels of which it is to form the basis; those to which the metals are to be applied require a great deal of fusibility, and it therefore becomes necessary that the frit should contain more of the flux; also to take care in this case not to employ a sand contrary to its nature, and to take the precaution to calcine it beforehand with a fourth part of its weight of marine salt, and to do the same also when we add the metallic fluxes, such as minium, or calcined lead. We thus obtain a white semi-vitrified mass, which, when pulverised, serves for the composition of enamel. But sometimes, in order to hasten the fusibility of the enamel, we employ a *calcine* made with a smaller proportion of tin; but this method is not often put in practice, and only for those enamels which do not require a considerable opacity.

There is also another motive for making certain particular changes in the proportion of the ingredients of the frit, which is the nature of the colours, which enter into the composition of the enamels. The oxides of lead, for instance, greatly injures many of these; and we are obliged in this case to have recourse to other kinds of fluxes. Clonet says, that he has chiefly employed a great proportion of the following mixtures, to serve as the bases for purples, blues, and other delicate colours.

Three parts of siliceous sand, one of chalk, and three of calcined borax; or, still better, three of white glass, of the Gobeline manufacture, one of calcined borax, one-fourth of nitre, and one part of diaphoretic antimony, well washed. These compositions produced a very white enamel, and which was afterwards changed to a perfect blue by cobalt.

Finally, we may conceive that we can very considerably vary the methods of forming the first material; but we must take care not to lose sight of the quality essential to a good enamel, namely, that of acquiring in a moderate fire sufficient fluidity to afford a good lustre, and be thin enough to run. It should not experience a complete fusion, but it should lose its pasty consistence; but, nevertheless, so that it should not appear, after cooling, as if it had undergone an entire liquefaction.

After this short explanation, we shall describe the most general processes employed to obtain the principal enamel colours.

Of the White Enamel Mat.—This kind of enamel requires the greatest care to be taken in the choice of the materials of which it is composed, and especially that they be free from any kind of tint, but be of a perfect whiteness; thus the frit which is employed in this case must be composed of the most pure materials. But it would not be always desirable to reject a frit, because it was a little coloured, as this colouration might depend upon two causes, either on certain metallic oxides, or on fuliginous particles, produced from organic substances; but it is easy, in these cases, to free it from them by means of a very small quantity of oxide of manganese, which possesses the property of readily giving up a part of its oxygen, and thus facilitates the combustion or destruction of the carbonaceous colouring matters. We might be surprised at seeing an oxide, coloured itself, but which, nevertheless, is capable of restoring whiteness; but we may remark, that the manganese does not possess this property of removing colour, but in its highest state of oxidation; and that it acts in a lesser degree, when it comes into contact with the combustible matters, and does not communicate any colour to the combinations of which it forms a part. It is evident, however, that we must not increase the necessary proportion of the manganese, otherwise the excess may produce a colour more or less distinct. Indeed we may say that it is sometimes necessary that the manganese should give a little colour, in order to produce a more agreeable white: it is on the same principles that we soften the glare of the white in woven fabrics, by the addition of a little blue.

The manganese has long been employed in glass-houses, with the same intent, and indeed some authors have given it the name of *the soap of glass*; but they employed it under the erroneous name of *magnesia.* We may here remark, that this name has given rise to many gross errors, because they thus confounded the oxide of manganese with the white magnesia, which is obtained from Epsom salt. Thus, in the *Dictionnaire des Arts et Metiers,* by l'Abbe Joubert, we must substitute *manganese* for magnesia, in his receipt for the preparation of white enamel.

Several ancient authors have directed us, in the preparation of white enamel, to add forty grains of manganese to five or six pounds of frit of the first quality, and to melt the whole in a crucible, placed in a brisk fire, perfectly free from smoke. When the fusion is completed, the fused mass must be poured into clear water, and be afterwards again melted. We must repeat this operation four times, if we would render the mixture perfect, and the reaction more complete. It is evident, after what we have before said, that the proportion of the manganese must be governed by the quantity of colouring matter to be destroyed; and, we may hazard the production of a disagreeable colour, by adding an excess of it; it is much better, therefore, to employ less than the necessary quantity, in the first instance; and to add afterwards small portions by degrees, till the intended effect is produced.

We may also form a white enamel with a *calcine* composed of two parts of tin, and one of lead. We take one part of this *calcine* and two parts of common glass, to which we add a small quantity of manganese. When the whole is well mixed, it must be melted as before directed. It is here also equally necessary, that all the principal matters of which this composition is formed be perfectly pure, otherwise it will be impossible to obtain the milky whiteness required; for example, we must avoid the exides of iron and copper, which are very frequently met with in all kinds of substances.

Some recommend, in forming white enamel, to employ washed diaphoretic antimony; but this substance must not be added to any preparation into the composition of which lead, or other metallic oxides enter, as in that case it would rather darken the colour than whiten it; it should not be used, therefore, in the making of common glass or saline fluxes.

We may take three parts of white glass, or crystal, and one part of washed diaphoretic antimony; mix them perfectly, and melt them in the usual manner, to form a white enamel.

Of Blue Enamel.—This fine colour is always obtained from the oxide of cobalt, whatever may be the other constituents of the enamel, and it produces such an intense colour, that if it were not employed in very small quantities it would become almost black. This colour is so rich and bright as to predominate, as we may say, over all others; and we must lower its tone, in some degree, but not so as to be perceptible; this is, however, easily accomplished. Nevertheless, to obtain this product in all its beauty, it must, as far as posssible, be freed from all others; and its colour will be the more clear, as the cobalt is the most pure.

Cobalt is mixed, in most of the mines known, with a great number of extraneous substances, such as iron, arsenic, copper, nickel, and sulphur, from which it is difficult to free it entirely. But it is necessary, in the formation of enamel, that it should be perfectly pure; and, particularly, it is absolutely essential to free it from the presence of iron, copper, and nickel, which are more prejudicial than the others; but it is easy to effect this purpose, by merely dissolving the mineral in the nitric acid, and evaporating the solution to the consistence of syrup, to drive off the excess of acid, and separate a part of the arsenic. It must then be diluted with water, and a solution of subcarbonate of soda be added, a little at a time; it must be stirred briskly, and the additions continued, until a deposit is formed, at first of a greyish white colour, but afterwards of a rose-colour. When this colour appears, we must stop the further additions, filtre the solution, and finish the precipitation of this filtered liquid by the carbonate of soda. We thus obtain the arseniate of cobalt sufficiently pure; and as the arsenical acid is not capable of giving any colour, and as it is volatile, so it does not injure the beauty of the blue; and it is thus obtained in great purity by this process.

Metallic fluxes are not proper to be used with this colour, as they always communicate to it a tint more or less strong, and which injures the purity of the blue. We have indicated, at the beginning of this article, those compositions which are most proper for the formation of this enamel; and we may add, that the nitrate of potash is necessary to carry the cobalt to its highest state of oxidation, a state in which it affords the most colour.

Of Yellow Enamel.—There are many processes for making this coloured enamel; but it is difficult to fix it, and we rarely obtain it uniformly of a good tone. We may produce it directly with the preparations of silver, such as the phosphate and the sulphate. This method is not, however, always used, as the employment of a heat too great, or the power of the fluxes, easily destroy it; nitre is also highly prejudicial. The uncertainty of succeeding with silver causes it to be seldom employed; we prefer to use the oxides of lead and antimony, which afford a fine yellow, when they are combined with other oxides sufficiently refractory to hinder the complete vitrification. We take, for instance, one part of the white oxide of antimony to three or four parts of white-lead, one of alum, and one of sal-ammoniac. We pulverise each of these substances, and then make a perfect mixture of them, which we submit to a heat capable of decomposing the sal-ammoniac. We judge that the process is completed when the yellow colour is well developed; it produces a combination exactly resembling that known by the name of Naples yellow.

We may also obtain other yellow tints with the oxide of lead alone; but if we add to it the red oxide of iron, its tints will be varied in proportion to the quantity of this last ingredient.

Clouet says, in his Memoir on Enamels, that we can procure a fine yellow with the oxide of pure silver, and that it is sufficient to lay a slight coat of it upon the part which you would colour. We therefore exposed a piece of enamelled work to a moderate heat, and withdrew it when we had carried it to a convenient degree; on removing a thin layer of reduced silver, which we found upon its surface, we saw, in the spot it had occupied, a tint of a very beautiful yellow colour, but without penetrating to any depth. We may observe, that, in order to be able to remove the pellct of silver which covers the colour, it is necessary not to fix this pellet by means of a flux; and, consequently, that it cannot be applied until the other colours are all fluxed.

In general, yellows require but little flux, and it unites better with them, from their metallic nature.

Green Enamel.—We know that a green colour is produced by a mixture of yellow and blue, but we rarely employ this method in enamelling, but obtain it directly either from the oxide of copper, or, still better, the oxide of chrome, which has the advantage of resisting a powerful fire.

Chemists are acquainted with two oxides of copper; the one, which is named the *protoxide*, is of a fine red colour, and communicates that colour to fluxes, but it is difficult to fix it. The other is the *deutoxide;* this is blue when in the state of a hydrate, and of a blackish-brown colour when it is *anhydrous*; its colour is green, in all the vitreous combinations of which it forms a part. This oxide requires one or two different proportions, or even more, of flux, accordingly as it may be in the saline or metallic states, to cause it to enter into complete fusion; but they usually employ too small a portion, and add a little oxide of iron. To four pounds of frit, for instance, they add two ounces of oxide of copper, and forty-eight grains of saffron of Mars; we must employ all the precautions we have before indicated to obtain a perfectly homogenous enamel.

Red Enamel.—We have said that the protoxide of copper affords a fine red colour when we are able to fix it; but we may add, that this result is exceedingly difficult to obtain, because this oxide is exceedingly fugacious; it is susceptible of losing or of receiving a new quantity of oxygen from slight variations of temperature. It is necessary, therefore, to know, and to seize the precise moment, and to withdraw it from the fire instantly that it has arrived at its proper degree of colour. Nevertheless, we may, in a slight degree, remedy the effect of the temperature, when it has not produced a super-oxidation, by adding a combustible material, such as charcoal, soot, tartar, &c. The copper then returns to its *minimum* of oxidation, and the red colour which had disappeared is produced anew. We might, perhaps, by this means, and by increasing the power of the heat, produce a complete reduction of one part of the oxide, and the particles of metallic copper disseminated through the red flux would give the enamel the appearance of the stone known by the name of the *aventurine*. M. D'Arcet thinks that the most beautiful imitations of the *aventurine* result from an enamel formed in definite proportions, and susceptible of a crystallization, which is produced in the manner of the damask or marbling of soap, and in which the crystals, being disseminated through a vitreous mass more fusible than the crystals, would give that beautiful appearance of this stone which we so well know.

The ancients have not pointed out any direct process for preparing the protoxide of copper; they obtained it from a mixture of the two oxides, and were obliged to restore the oxidation, more or less, by the method we have described. But now that we possess the means of procuring this oxide in a state of purity, the manufacturers begin to abandon those processes, more or less fantastical, which we find in the old treatises, since they tend only to produce imperfect results. We propose, as a certain method, and easy in execution, that pointed out by M. Vogel. It consists in boiling a solution of equal parts of sugar, and of the sulphate, or, still better, the acetate of copper, in four parts of water. The sugar takes a portion of the oxygen from the oxide of copper, and it remains in the state of a protoxide; it then precipitates in the form of a granulated powder, of a brilliant red colour. In about two hours the boiling is finished, it is suffered to precipitate, the water is poured off, and it is washed and dried for use.

This fine oxide is very easily and conveniently used, and affords a red which does not yield to that of the most pure carmine; and it may be obtained in this way, of all the shades from red to orange, by adding more or less of the oxide of iron.

The preparations of gold, and especially the oxide, or the purple of Cassius, are also used with advantage to colour enamel red, and this preparation also resists well a vehement heat. For some time they have used with success the solutions of gold, platina, or silver, instead of their oxides, and have obtained by this means a more intimate mixture, and, in consequence, more homogenous tints.

Black Enamel.—Black enamels are formed with the protoxide of manganese and the protoxide of iron; and to give more intensity to the colour, they add a little cobalt. Argil alone, according to Clouet, affords a fine black enamel.

Violet Enamel.—The peroxide of manganese alone, in a small quantity, furnishes, with saline fluxes, an enamel of a fine violet colour; and is easily obtained, in a variety of tints, by modifying the proportions of the elements of the first. The essential thing is to preserve the manganese in its highest state of oxygenation, and, consequently, to avoid the mixture of any substance, in combination with it, capable of reducing it.

These are the principal enamel colours which are obtained by means of the metallic oxides; but the number of these oxides are daily increasing, and it is therefore desirable to make new experiments, in which they may be employed. In the progress of these experiments, there is no doubt but that many interesting results would be obtained.

C.—*On the Comparative Qualities af Gunpowder**.

"GUNPOWDER, to be good, should be quick, strong, free from impurity, and not liable to attract moisture from the atmosphere. The general method of trying the purity of gunpowder, is by burning it on clean white paper: two or three small heaps are made near each other, and one of them is fired; if the smoke rises perpendicularly, and there be no feculent matter left on the paper, nor the other heaps fired, it is considered as evidence that the ingredients have been of a good quality, and well compounded. If, however, the other heaps are fired, the paper burnt, or a dirty residuum left, it may be supposed that the nitre was impure, that the charcoal was not completely pulverized, or the whole of them were not well incorporated together. It is remarkable that powder will vary in its proof at different times of the day, and from what cause we know not; in truth, notwithstanding it has been in use for four hundred years, we are still but partially acquainted with the nature and properties of this article.

"Several methods of proving or trying the strength of gunpowder have been adopted; but, with the exception, perhaps, of Mr. Dupont's Eprouvette, none of them can be relied on for much accuracy, when used for fine powder. The mortar is very uncertain, and the spring eprouvette is worse than useless, and should be abolished.

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* From *The American Shooter's Manual*, but republished in the *Franklin Journal.*

" There is certainly no nation in the world where manufactures in general have so justly become celebrated as Great Britain, and in no article, perhaps, more than in gunpowder. The French powder has been highly spoken of, but by experiments made upon what is called '*king's powder,*' made expressly for the king of France and his court, and which is doubtless the best made in France, it will not be found to bear comparison with that of Pigou, Andrews, and Wilkes*, which is no doubt the best foreign powder ever introduced into this country.

" Dupont's Eprouvette is nothing more than a small chamber, capable of containing about the charge for a patent breech fowling-piece, placed in a vertical position, so that the action of the powder is upwards; when loaded, a weight of about four pounds, attached to a lever, is let down so as to cover the chamber. To the moveable end of the lever a graduated ribband is so attached, that when explosion takes place, the weight is thrown up, taking with it the ribband, which passes through a small hole; the weight, of course, again falls to its place, but the ribband is held by the slide, at the point to which the force of the powder carried the weight.

" When the strength of gunpowder has been tested, its quickness in firing may also be proved, in a manner invented by Mr. A. Dupont. The method of thus testing quickness is both simple and satisfactory. It is nothing more than burning a train of twelve feet, or one hundred and forty-four inches, of each of the samples to be tried; these trains are laid parallel to each other, and the board they are laid upon being graduated, you can thus plainly see the comparative quickness of each sample."

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* Of Dartford, Kent.—Ed.

Remarks upon the Properties essential in good Gunpowder, and upon the Methods of Testing its Strength.

By JOSHUA SHAW, ESQ.

SIR, *Philadelphia, July* 18, 1827.

Being a constant reader of your journal, and always interested in new discoveries and improvements, my attention was arrested by an article in your last number, on the strength of gunpowder. The subject is one of which I may claim some knowledge, from a practice of more than thirty years in the sports of the field, and from having myself performed numerous experiments in relation to it, and paid much attention to the experiments and opinions of others.

Although I differ in some respects with the writers of the "Manual," we all agree, that powder to be good should be quick, strong, free from impurity, and not liable to attract moisture from the atmosphere. In the article alluded to, it is said, that "several methods for proving or trying the strength of gunpowder have been adopted, but with the exception, perhaps, of Mr. Dupont's eprovette, none of them can be relied on for much accuracy." Now, in my opinion, this eprovette is equally defective with those usually employed, and which I consider as worse than useless. Their great fault is, that a similar result may be obtained with them from powder which is strong, and from such as is comparatively weak, but which excels the former in quickness.

The real strength of powder depends upon the quantity of gas resulting from its explosion; the coarser kinds frequently yield more than the finer; every experienced sportsman knows, that with coarse powder he can kill wild-fowl at a greater distance than he can with the best canister, although the measure of both be the same; yet in this case the weight of the fine will exceed that of the coarse. The blow upon the shoulder, it is true, will be more powerful from the fine, that from the coarse being scarcely felt; the cause of this is, the coarse burns with comparative slowness, and giving out a large volume of gas, the elastic force increases until the shot leaves the muzzle of the gun; whilst that which is fine, being generally quicker, has every grain ignited at nearly the same moment, and exerts a sudden force, which is felt like the blow of a hammer; but this force does not continue, but relaxing before the shot is discharged, these latter are retarded by friction, and pass on with decreased velocity. A little reflection will make it apparent, that the quickest, not always the strongest, powder will tell best, either in the eprovette described, or those referred to in the article in question. It is true, that the quickest powder may be also the strongest, but the test given is fallacious, and is calculated to lead into error; besides which, were the means good, but few persons could avail themselves of them, as they have no good instrument at their command. I will therefore describe the mode which I have followed, and which can be practised by every one, but I will first add a few words, upon the properties of gunpowder.

In field sports the percussion gun has effected a considerable revolution, having caused such gunpowder to be preferred as was formerly rejected. *Strength,* not quickness, is now the important point, because the fulminating powder used for priming these guns, distributes the fire with the quickness of lightning throughout the whole charge, and at once ignites every grain; thus rendering, what in the old gun was slow powder, many times more rapid in its combustion than the quickest powder formerly was. A quick powder is rendered so much more so, when ignited in this way, as to resemble in its action some of the fulminating powders; and, consequently, to endanger the bursting of the gun. The English manufacturers are evidently aware of this effect, as is evident in a number of the guns lately imported into this city; they are thickened near the breech, whilst they are kept as light as usual, by lessening their thickness in other parts, where the metal might safely be spared.

The effect of a too rapid explosion may be illustrated by the action of the fulminating powders, of which there are several kinds. A small charge of these will burst the strongest fowling-piece, but will not throw a ball ten paces! Although strength is always an important point, I think that it must now be manifest, that it is dangerous to confound this property and quickness with each other.

Impure or dirty gunpowder is the detestation of every sportsman, as it is a fault without remedy. If his powder be weak, he may add to his charge, and obviate this evil. I have freely used Dupont de Nemours and Co.'s Brandy-wine gunpowder, and also Pigou and Company's, and have consulted with many of my friends who have used both, and all have agreed that the Brandy-wine gunpowder is both strongest and quickest; but all have agreed that it is much less cleanly, soiling the gun more than Pigou's, and giving to water in which the barrel is washed an ink-like appearance; whilst a greyish tint only is produced by the latter, without much injuring the transparency of the fluid.

Had the English powder intended for ordnance been tested, it would have probably been found, that the English manufactured article is not equalled by that made in this country. This at all events was the case with a quantity found on board the Lady Johnson, captured during the last war on her voyage to Canada. The fact rests on the testimony of every one who had an opportunity of trying it. This is a point of great importance, and well worthy the attention of the government, and of the manufacturers of the article.

I will now describe the mode which I have adopted, in testing the *strength* of gunpowder. The method which I employ may not be scientific, but it is nevertheless certain, and uniform in its results. I fix up a piece of board vertically, having a hole in it of from six to eight inches in diameter, and over which hole I nail a quire of paper by its two upper corners; the sheets are compact as taken from the ream; writing paper is to be preferred. This is my target, at which I fire from a distance of thirty or thirty-five yards. My shot is weighed and the powder measured with some care, and, before firing at the target, I turn up six or eight leaves of the paper, placing over them a loose board, to protect them from the shot. I then fire, say No. 6 shot, and if the powder be strong, many of the pellets will pass entirely through the paper: if more than half pass through, I turn down some of the sheets, and thus proceed, until the paper is again perforated by about one-half of the number of shots discharged. Other kinds of powder may now be compared with that first used; one may not cause a single pellet to pass through, whilst, from another, the whole charge may pass; by increasing or decreasing the number of sheets, you may find a difference of twenty per cent., and that in favour sometimes of powder which appeared the weakest by the common eprouvette. The correspondence between this mode and the practical use of powder is apparent, and experience has proved it to be the best.

The trial by firing gunpowder on white paper is altogether fallacious, some kinds not soiling it, which yet are absolutely filthy when used in the gun, and some burning quickly in the loose heap, which act slowly when rammed down.

I trust I have proved, that quickness is a property in gunpowder, much less desirable now than formerly, and that elastic force and purity are the main requisites.

Should you, sir, however, wish for farther evidence upon this point, it will afford me pleasure to furnish you with my mode of testing the quickness of gunpowder, which measures the time required to burn different kinds of gunpowder with such accuracy, that in numerous trials, the difference in the results will be a mere fraction.

In offering these views, I have not been prompted by any invidious motive; my aim has been to ascertain the truth. And, having had much practice in the use of gunpowder, I have attempted to describe what I have actually observed; and if I have succeeded in making known any thing which may have escaped the notice of others, my observations will possess some value.

I am, sir, very respectfully yours,
JOSHUA SHAW.

To Dr. THOMAS P. JONES,
Editor of the *Franklin Journal.*

CI.—*Notice of a New Engine possessing great power, now constructing in the vicinity of Philadelphia. By* JOSHUA SHAW, *Esq.*[*]

SIR, *Philadelphia, July* 10, 1827.

BELIEVING that any information relative to the progress of improvement in the mechanic arts will be acceptable to you, I send you some intelligence respecting a machine which will soon be before the public.

A person residing in the neighbourhood of this city has lately completed a small engine, which, in my opinion, will combine safety, simplicity, and economy, in a degree surpassing any of the steam-engines now in use. As the engine of which I speak will soon be ready for public inspection, when you will have an opportunity of judging for yourself, I will not now attempt to describe its structure, but merely state some of the advantages which I believe it will present.

It will be free from the heat and the danger which accompany highly elastic steam, and also from all tremulous motion and rumbling noise. It will occupy but little space, and is so silent, that it will scarcely be heard. There is no fire, no boiling water, no burning of gas. It is light, simple, and efficient: dissipating, at first sight, all those apprehensions which other engines are calculated to excite.

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[*] From the *Franklin Journal.*

It can be regulated so as to work with a pressure of from one to six hundred pounds upon the square inch, with a very moderate strain on any given part of the machinery. The ingenious inventor, whose name will appear in due time, pledges himself that an engine of sixty horse power shall be kept at work night and day, for one month, at a cost not exceeding ten dollars!

I am, sir, very respectfully yours,

JOSHUA SHAW.

To Dr. THOMAS P. JONES,
Editor of the *Franklin Journal.*

Remarks by the EDITOR *of the Technological Repository.*

We can only say, that if the projector of this new engine can but realize one-half of his expectations, he will perform what has never yet been accomplished or even contemplated by any one else. We fear it will be long, however, before his engine will be visible, and wish his friend Mr. Shaw may not have been too sanguine in his expectations in this instance, as well as in another, which he mentions in the above letter.

CII.—*On the Manufacture of Naples Yellow* *.

THIS colour has long been prepared by the Italians, under the name of *giallolino.* Its real composition is but little known, not for want of receipts for preparing it, but because we possess a great number which do not agree with each other. From this difference in its composition arises the variety of tints in it, as furnished by each manufacturer. Naples yellow is a colour esteemed by artists, on account of its cool tint, its brilliancy, and its richness; but it would be desirable that it should be always alike in quality. It is used not only in oil painting, but it is employed likewise with advantage for painting in enamel, on stoneware, and on porcelain.

We shall extract from Passori's work, entitled, "*Nuovo*

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* From the *Dictionnaire Technologique.*

raccolta d'opuscoli scientifici," published in 1758, t. iv. p. 103, the best receipt for the preparation of this colour, which results from the following mixture:—1 pound of calcined antimony, 1 pound eight ounces of calcined lead, 1 ounce of marine salt, 1 ounce of what is here termed *allume de feccia,* but which is in another place termed *alum,* and in another *tartar;* and thus, necessarily, great differences will arise in the results, according to the one or the other of these versions.

Thus also Fougeroux, in the *Memoires de l'Academie des Sciences,* for 1766, recommends to boil for seven or eight hours, at first over a gentle fire, but, finally, over a vehement one, a mixture of 12 parts by weight of white lead, 1 of alum, 1 of muriate of ammonia, and 3 of diaphoretic antimony.

We really cannot see of what use the alum can be in this process; it surely cannot act as a colouring material, nor as a flux. We must therefore presume that it should rather be tartar, or its alcali, which should be employed; and this becomes the more probable, as Passori, in the different receipts he has published, also uses the word *feccia,* meaning by this expression what the Italians understand as tartar, the deposit of wine.

We are, upon the whole, inclined to think that it is the alcali of the tartar, and not the tartar itself, which should be used to oxidize the metals which enter into this composition, and that the action of the acid of the tartar, in first oxidizing them, is altogether useless, since we necessarily determine to effect the reduction of these oxides. And we may remark, in fact, that in the receipt given by Tongereux, he prescribes diaphoretic antimony, or this metal in the state of an oxide, and which also contains a fifth part of potash. Thus then, this condition of oxidation does not appear to be alsolutely necessary, at least entirely, because when we employ the marine salt and the sal-ammoniac, we should suppose that these form chlorures, and contain the metals in a radical state. In fact, the quantities of sal-ammoniac and marine salt mentioned in all the known receipts are not sufficient to convert all the proportion of oxides into chlorures. Of some of these compositions, at least, the muriates form a part, if not of the whole, and the results are combinations of oxides and chlorures—combinations analagous to the red antimony, which, according to Proust, is formed by the union of a metallic sulphur and an oxide.

We do not possess any analysis of Naples yellow which will permit us to establish an opinion founded on this point, but it would be of great service, were some able chemist to undertake to analyse it. We shall now proceed to give various receipts which have been published, in order that every one may choose amongst them.

Passori, whom we have before quoted, has given many of these receipts, not only as affording different means of obtaining this colour, but, more particularly, with a view of procuring the various tints of it. The following are the various processes:—

1. Six pounds of lead, 4 pounds of antimony, and 1 pound of tartar *(feccia)*.
2. Three pounds of lead, 4 pounds of antimony, 1 pound of tartar, and 6 ounces of common salt.
3. Five pounds of lead, 4 pounds of antimony, 6 ounces of tartar.
4. Four pounds of lead, 2 pounds of antimony, and 6 ounces of tartar.
5. A pound and a half of lead, 1 pound of antimony, 1 pound of tartar, and 1 pound of common salt.
6. Three pounds and a half of lead, 2 pounds of antimony, and 1 pound of tartar.

It is to be understood, that the metals must all be previously in the state of oxides before being mixed, and submitted to fusion.

We find in "*Du Voyage en Italic*," by Delalande, published in 1786, vol. iv. p. 504, a process for making Naples yellow, which was communicated to him by Prince

San-Severa, and in which nothing is found but lead and antimony, viz.:—Lead, perfectly oxided, and finely sifted, 3 parts; antimony, also oxided and sifted, 1 part. Carefully mix them, and to render the mixture more perfect, pass them through a silken sieve; lastly, place the powder, of the thickness of two inches, on large plates of glazed earthenware, cover them with leaves of white paper, and place them in the upper part of a potter's furnace, where they may not be exposed to too great a heat; the mere reverberation of the flame upon them will be sufficient. The plates may be withdrawn with the rest of the pottery ware, and we shall obtain a hard mass of a yellow colour.

Some authors introduce the oxide of zinc, and others that of bismuth, into the composition of Naples yellow. Thus, as we see, the elements of this colour are greatly varied; and it is not strange, therefore, that we find in commerce such different tints of it. We shall finish by giving two other receipts, which we know have afforded good results. The first consists in mixing 12 ounces of antimony, 8 ounces of minium, and 4 ounces of oxide of zinc. The whole being well mixed and sifted, must be submitted to the action of heat, in the same manner as in the receipt published by Delalande.

For the second process, we take—1 gros of diaphoretic antimony, 1 ounce of muriate of ammonia, and 1 pound of pure oxide of lead, either minium or litharge. We mix and sift the whole perfectly together, and melt it in a crucible.

This operation requires very excellent crucibles, as the mixture is a flux, and immediately attacks those which are not refractory.

In those manufactories which prepare this colour in the large way, they employ a reverberatory furnace, in the vault of which is an opening sufficiently large to enable them to put in and remove the crucibles commodiously. This is an operation which necessarily requires much attention, and therefore each workman ought not to have more than four or five crucibles placed under his care, and they should be arranged in such a manner in the furnace, that the process should not be terminated sooner in one than in another.

When the matter is perfectly fused, and at a reddish-white heat, it must remain in this state about five minutes; and then the crucible must be removed from the furnace, and the mixture be poured into an iron pot; the bottoms of the crucibles must then be attentively examined, and if there are not found any deep cracks in them, they may serve for another operation; otherwise, they must be replaced by other crucibles.

Pipes or tubes are generally used for stirring the matter in fusion, when necessary. But we must avoid as much as possible the bringing of iron into contact with this colour, as it always injures it.

It is essential also that the charcoal employed in this fusion be very dry, otherwise it will crackle, and thus throw portions of it into the matter, which will partially reduce the oxides, and cause certain small grains to form in it, which will produce dirty stains in the colour.

CIII.—*On the different Black Colours. By the late celebrated* William Lewis, *M.B., and F.R.S.*

(Continued from page 319.)

II. *Composition of Ink, deduced from the Experiments.* The foregoing experiments point out for the best proportion of the ingredients, one part of green vitriol, one of powdered log-wood, and three of galls. The best menstruum appears to be vinegar or white wine, though for common use water will suffice. The quantity of menstruum admits of great latitude: to make an ink of a full body of colour, it should not exceed one quart, or at most three pints, to three ounces of the galls, and one ounce of the other ingredients. The proportion of gum may be varied at discretion, according as the ink is wanted more or less glossy or shining, or as the nature of the paper may require the fluid to be well gummed to prevent its sinking, half an ounce to a pint is, in most cases, sufficient; though the more gum we can employ, consistently with due freedom of writing, it is probable that the ink will be more durable.

The ingredients may be all put together at once, in any convenient vessel, and well shaken four or five times a day. In ten or twelve days, and sooner if set in a warm place, the ink will be fit for use; though both its colour and durability will be improved by standing longer on the undissolved ingredients. The ink thus prepared, though it flows pale from the pen, turns to a good black in a day or two after writing.

Or the logwood and galls may be first boiled in the liquor for half an hour or more, with the addition of a little more liquor to make up for that which evaporates in the boiling. Strain the decoction while hot, and having put it into the vessel which the ink is to be kept in, add to it the vitriol and the gum; as soon as these are dissolved the ink may be used. By this way of managing the process, we obtain all the advantage of boiling, and the separation of the gross feculence, without daubing any other vessels or utensils than the ink-vessel itself; the ink is expeditiously made, and writes of a pretty full colour.

Common pale ink, prepared by cold maceration, may be improved, so as to write black at once, by evaporation. It may be set in such a heat as will make it visibly steam, not greater, and the heat continued, until on trying the liquor now and then, it be found to be of sufficient blackness. On the same principle, when ink is kept in an open ink-stand, till it begins to grow somewhat thick, from the exhalation of part of the watery fluid, it writes as black as can be wished; and when grown too black to be conveniently written with, it gives blackness to a certain quantity of fresh ink. Hence, when we have a pale ink to be thus improved, it will be sufficient in many cases to evaporate to blackness only a part of it, and to dilute this occasionally as it thickens in the ink-stand with some of the rest, stirring them well together after each addition, as the thickened and dilute inks do not very readily unite; if the evaporation was suffered to continue till the black matter remained dry, it would scarcely dissolve at all in common ink or in water. There is another method of giving blacknesss to inks, by the addition of some of the black pigments formerly mentioned; but the use of these pigments for writing will make the subject of another article, at the end of this section.

As the galls and logwood ought to be in pretty fine powder, that their virtue may be more readily and effectively extracted, it is expedient to have the ink separated from them, as in the second of the above processes; because otherwise the ink would often be loaded with the finer parts of the powder in substance, which being mixed up by shaking the vessel, remain long suspended in the liquor. It is proper, however, in order to be secure against any danger of a deficiency in the astringent materials, to add to the ink, separated from its feculence, some galls in coarse powder, freed from the fine dust by a sieve. On the same principle, an oaken cask is one of the best vessels for keeping ink in, this wood having a manifest astringency, and answering nearly the same end with the additional galls. Besides the galls, some pieces of iron may be put into the vessel, as before mentioned.

III. *On the Preparation of Parchment and Paper for Durable Writings.*—The dyers, as we shall see hereafter, prepare their cloth for receiving a permanent black colour, by boiling it with galls, that it may be thoroughly penetrated by the astringent part of the galls, before the vitriol is introduced; so that wherever the vitriol can reach it meets with astringent matter, to unite and produce a black with.

It is observable, that writings first begin to fade or change their colour on the back of the paper, where the large strokes have sunk in, or are visible through it, as if part of the irony matter of the vitriol was in a more subtile or dissolved state than the rest, and sunk farther into the paper, on account of its not being fully disengaged from the acid, or sufficiently combined with the astringent matter of the galls.

Hence it should seem probable, that if the paper was impregnated with astringent matter, the colour of the ink would be more durable, and that, therefore, a practice similar to that of the dyer would be a valuable addition to the business of the paper maker.

To see how far this notion was well founded, I dipped some paper into an infusion of galls, and when dry repeated the dipping a second and third time. On the paper thus prepared, and on some of the same paper unprepared, I wrote with different inks, several of which, that the effect might be more sensible, had an over proportion of vitriol. The writings being exposed to the weather till the best of the inks on the unprepared paper had faded and changed their colour, those on the prepared paper were all found to retain their blackness.

It is therefore recommended to the consideration of the paper makers, whether a particular kind of paper might not be prepared for those uses, when the long duration of the writing is of principal importance, by impregnating it with galls, or other astringents, in some of the operations which it passes through before it receives the glazing; as, for instance, by using an astringent infusion, instead of common water, in the last operation, when the matter is reduced into a pulp for being formed into sheets. The brownish hue which the paper receives from the galling would not, perhaps, be any great obstacle to its use; and if the proposal should be thought worthy of being carried into execution, further enquiries may possibly discover means of obviating the imperfection, and communicating astringency without colour.

An astringent matter might be introduced also into parchment and vellum. The common tanned skins, as already observed, and not only those of the softer kind, but the firm soles of shoes, have the very impregnation which we here propose to communicate to the finer skins used for writing. I steeped a thick piece of parchment in water, along with some oak-bark, for three or four days, and having then pressed it smooth and dried it, I found it as effectually penetrated with the matter which makes ink durable, as the paper in the experiment before mentioned. Even when the surface of the parchment was pared off, and the internal part written upon, the characters continued of a good black, while those made with the same ink, on unprepared parchment, were changed to a yellowish brown.

It may here be observed, that an impregnation of paper with one or both of the ingredients of ink, has been sometimes already practised in a more imperfect manner, and with a view rather to amusement than to the answering of any useful purpose. Galls in fine powder, being well rubbed into the paper with a hare's foot, a solution of vitriol, made so dilute as to have little or no colour, writes black upon the paper so prepared, forming with the galls, in all the parts it touches, an extemporaneous ink upon the surface of the paper. If powdered vitriol be first rubbed in, the same blackness is produced by infusion of galls; and if powdered galls and powdered vitriol be mixed and applied together, both in a very dry state, that they may not act upon one another, plain water makes a black writing.

But though practices of this kind should in some cases be convenient, as for making occasional minutes, in want of ink, with common watery fluids; or for the purpose mentioned by Boyle, the keeping the fingers from being blackened, by using colourless fluids for writing with, it is plain that the inks thus produced must be in greater danger of fading than those made in the common manner, as the proportions of the ingredients, which form the ink, cannot be ascertained, and will be different on different parts of the paper. The preparation before recommended depends on a different principle, in regard both to the intention and the means; for here the preparation is only superficial, while there it is diffused through the substance of the paper: the intention here is only the producing of a black colour on the surface, by applying a fluid which has no blackness; while there, the paper is impregnated with the material which is most perishable in ink, in order to continue the blackness beyond the period in which that of the ink itself would decay.

IV. *Attempts to prepare an Ink from more durable Materials.*

To introduce into writing the ink whose permanence we see daily in printed books, appeared so desirable an object, that though there were small hopes of attaining it, its importance seemed to deserve some trials.

Printers' ink, as we have seen in the foregoing section, is a thick mixture of lamp-black and oil; and such a mixture, though diluted with more oil, is evidently unfit for writing. Instead of oil, I mixed both lamp-black and ivory-black with a solution of gum arabic, made of such consistence as just to flow sufficiently free from the pen. The liquors wrote of a fine black colour, but when dry, part of the colour could be rubbed off, especially in moist weather; and a pencil, dipped in water, washed it away entirely.

I tried solutions of the animal glues with the same event. Isinglass, or fish-glue, being the most difficultly dissoluble of these kinds of bodies, I made a decoction of it in water, of such a strength that the liquor concreted into a gelly before it was quite cold: with this gelly, kept fluid by sufficient heat, I mixed some ivory-black: characters, drawn with this mixture on paper, bore rubbing much better than the others, but were discharged without much difficulty by a wet pencil.

It was now suspected that the colour could not be sufficiently fixed on paper without an oily cement. As oils themselves are miscible with watery fluids by the intervention of gum, I mixed some of the softer printers' varnish, already described, with about half its weight of a thick mucilage of gum arabic, working them well together in a mortar, till they united into a smooth uniform mass: this was beaten with lamp-black, and some water added by little and little, the rubbing being continued, till the mixture was diluted to a due consistence for writing. It wrote freely, and of a full brownish-black colour: the characters could not be discharged by rubbing, but water washed them out, though not near so readily as any of the foregoing. Instead of the printers' varnish or burned oil, I mixed raw linseed oil in the same manner with mucilage and lamp-black, and on diluting the mixture with water, obtained an ink not greatly different from the other.

Though these oily mixtures answered better than those with simple gums or glues, it was apprehended that their being dischargeable by water would render them unfit for the purposes intended. The only way of obviating this imperfection appeared to be, by using a paper, which should admit the black liquid to sink a little into its substance. Accordingly I took some of the more sinking kinds of paper, and common paper made damp as for printing, and had the satisfaction to find, that neither the oily nor the simple gummy mixtures spread upon them so much as might have been expected, and that the characters were as fixed as could be desired, for they could not be washed out, without rubbing off part of the substance of the paper itself.

All these inks must be now and then stirred or shaken, during the time of use, to mix up the black powder which settles by degrees to the bottom: those with oil must be well shaken also, though not used, once a day, or at least once in three or four days, to keep the oil united with the water or gum; for if once the oil separates, which it is apt to do, by standing at rest for some days, it can no longer be mixed with the thin fluid by any agitation. But though this imperfect union of the ingredients renders these inks less fit for general use than those commonly employed, I apprehend there are many occasions in which these kinds of inconveniences will not be thought to counterbalance the advantage of having writings, which we may be assured will be as lasting as the paper they are written upon. And, indeed, the inconvenience may be in a great measure obviated, by using cotton in the ink-stand, which, imbibing the fluid, prevents the separation of the black powder diffused through it.

It has often been remarked, that the inks used in former times were far more durable than those of later years, many modern records being more decayed than the manuscripts of much greater antiquity. Camillo Paderni, in his letters from Herculaneum, published in the Philosophical Transactions for the years 1753 and 1754, speaking of the ancient Roman and Greek volumes discovered there, written on the Egyptian papyrus, complains of the paper being so much decayed and rotten, that they have been able to unroll only a few pieces, but makes no complaint of the ink having any where faded, all the parts that have been unrolled seeming, from what he says of them, to be legible enough. In one place he mentions expressly, the characters being of a very black tint, exceeding that of the coal to which some parts of the paper were reduced. This observation occurring to me on revising the foregoing experiments, I was induced to look into the Greek and Roman writers, who flourished before the destruction of that city, to see if any account could be found in them of the ink they made use of.

(*To be continued.*)

CIV.—*On the Management of Bees, and raising Stocks of them. By Mrs.* M. CLIFTON, *Mr.* GEORGE HUBBARD, *and Mr.* THOMAS MORRIS.*

SIR, *Timberland Thorpe, July 27, 1790.*

IN the eighth volume of your transactions, a premium is offered, class one hundred and eight, for the greatest number of stocks of bees, not less than thirty. I having that number in my possession, am induced to make my claim for the same.

My mode of raising them has been as follows: about fifteen years ago, I bought one stock of bees, and, having great success, increased their number by degrees, till I had thirty stocks, and should have sent a claim last year, had I known there had been a premium for them. The method of keeping them, is in a straw hive, standing on a stone, supported by three oak stakes, about eighteen inches high, the stone to project a few inches over, to prevent mice from destroying them; also a covering, made of wheat straw, fixed over each hive, to prevent the rain from entering therein.

The method of keeping them alive in winter, is by feeding them with honey every other day, from the beginning of December to the latter end of March. Warm the honey, and pour it into plates, and lay upon it clean wheat straws, near to each other, to prevent the bees from being drowned in the honey: they will sit upon the straws, and take the food clean from the plates.

MARGARET CLIFTON.

Witnesses to the truth of the above—W. Broadbent, Vicar of Timberland; Francis Ward, Timberland; John Fish, surgeon, Sleaford.

To SAMUEL MORE, *Esq. Sec.*

SIR, *Bury St. Edmunds, Oct. 29, 1790.*

As I am induced to become a candidate for the premium offered for the stocks of bees, class one hundred and eight I beg leave to communicate to the society the following experiments, the result of which, I flatter myself, will afford some information towards the management of those useful insects. In my early acquaintance with these entertaining creatures, my endeavours to increase my stock were continually disappointed, particularly in the early months, by saving moderate stocks, which was a matter of surprise to me, as my strong stocks throve amazingly, whether I kept them for work or swarming.

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* From Vol. IX. of the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

Now, to ascertain the matter with sufficient accuracy, I determined to sacrifice three hives every year, one strong, and two moderate ones. Accordingly, on the first of February, I suffocated a strong hive, after Thornley's method; and when I took out the combs, it surprised me much to find an abundance of brood: the eggs and maggots were innumerable, and many were next to emerging from their cells.

It was then obvious to me, that the queen had begun to lay her eggs in the early part of January; and this appeared the more extraordinary, as the month of January had been very cold, from severe frosts and snow; and it was evidently too sharp for a bee to stir abroad.

This circumstance refutes the generally received opinion, that the queen never begins breeding till the weather proves mild, and you see bees carrying to their hives the little balls of farina on their legs: but to investigate the matter more fully, there appeared in the combs vast quantities of farina; and what was very curious, some of it seemed covered with a kind of varnish substance, in order to exclude the air from it; besides, on the top of the hive, there was a considerable quantity of water, apparently collected there from the same cause that it does on a window, where a room is hot, and the external air very cold. The foregoing consideration clears up a point that has puzzled many authors; I mean the laying up such quantities of farina: White, and some others, suppose it to be real food, mixed with honey, for the old bees.

The second hive, which had not above three pounds of honey in it, I suffocated on the first of March; the queen of which stock had not produced a single egg; the third stock I examined the first of April, and there likewise found no eggs. In the second year, I repeated the same experiments with the strong and weak hives as before, and the result was the same in every respect.

But the third hive I reserved till the 20th of April, by which time they begin to gather honey from the gooseberries: on examining this hive, I found some eggs produced. Let it be observed, that this hive I was under the necessity of feeding, to keep them alive.

I cannot in this place forbear taking notice of the surprising foresight which these wonderful insects seem to be endowed with; in the weak hive, not a single egg is produced, till honey gathering commences; but in the strong hive, the increase of young bees is there carried on with surprising avidity at a time when they are generally supposed to be in a torpid state; and this increase is perfectly safe in a strong hive, for they are never observed to work in the early months, as weak hives do.

From the above experiments, it is evident you gain almost four months between the two stocks; besides, early in May the strong stock is almost ready to swarm; whereas the weak hive, by its prodigious decrease, occasioned from their constant working, and no young ones being bred, generally dwindles to nothing, Once, on a hot day in April, I had five of these weak hives driven out by plunderers, with their different queens; for the strong stocks never let the weak ones rest, when they find the latter are much reduced.

Sometimes, if the months of March and April happen to be cold and wet, so as to prevent their going out, a little feeding may give them sufficient strength to defend themselves; but those stocks seldom turn to any account:

hence the reason why keeping bees in colonies have always failed, I mean in this country; for if you imprudently reduce your bees, by taking too much honey from them, so as to prevent the queens breeding in the early months, they must miscarry in the following summer. I cannot help condemning two authors that have written on this subject, viz. Messrs. White and Keys, particularly the former: their opinions have given a surprising check to the cultivation of bees; I mean, their idle notions respecting situation.

A popular opinion prevails with us, that no village will support more than eight or ten flocks; consequently, the villages in our country do not contain above ten old stocks, one with another; whereas I am confident that twenty times the number might be kept. But let us examine what Mr. White has written on this business: he directs you to swarm your bees, and the same year to take part of their honey from them.

Now it is well understood, that it requires a large swarm, aided with a fine season, to make them produce five and twenty or thirty pounds weight in October, which weight is absolutely necessary for their future welfare: he also affirms, that if you leave them eight or ten pounds of honey in August, it will very well support them through the winter. Further comments on such management are needless, as the reason of his failure is too obvious to require the thought of a bad situation to account for it.

Keys seems to have copied his sentiments respecting situation; but from what I have advanced in regard to keeping such a number of stocks, it may be necessary to examine what the bees collect from. I will first mention the tare, that inexhaustible support of bees, from which they gather the whole summer; and it may not be improper here to note, that it is not from the flower, but a small leaf* with a black spot on it, which in warm weather keeps continually oozing. But from careful inspection at the time of their gathering, this nectareous juice may be seen oozing from every joint of the stem. A hundred acres of tares are grown every year within the reach of my bees; yet it was always said to be a bad situation, and not able to support more than eight or ten stocks; besides, if the month of June proves hot, the collection from the oak, lime, and sycamore leaves, is astonishingly great; as well as from the profusion of flowers, which nature exhibits in succession throughout the whole summer.

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* The *stipulæ*, or leaf scales, which are marked underneath with a spot, as if it had been burnt.

From these remarks and experiments, it is evident that success depends entirely on leaving your bees strong in October; for by this plan they naturally get into a habit of swarming early, and, by having the whole summer before them, always get rich. Whenever an unkindly season happens, to prevent this, it is an invariable practice with me to give all my swarms sugar and water, or honey, sufficient to make each stock produce thirty or thirty-six pounds weight: besides, I am never disappointed of a swarm in May; and it is more frequent than otherwise, that these stocks will yield three swarms each; the old stock likewise in general will be as rich as the prime swarm. On the other hand, if the stock is left moderate, though they may have honey enough to get them through the winter, yet some check may be given to the queen's breeding; of course it may be the middle of June before they are ready for swarming; and if the weather turns out fine and hot, there is such a profusion of honey in the fields, and they are so intent after it, that no art can make them swarm: in that case, they will lie out the remainder of the summer, to the great loss of the owner. However, whenever this happens, I would advise all such stocks, after lying out a week, to be set on empty hives.

I will now presume to offer a simple and easy mode of managing these admirable insects, the profits from which will far surpass that in common use. The owner must patiently wait till he has acquired twenty stocks, which may be soon accomplished by attending to the foregoing hints. In the month of April following he must separate ten of the strongest hives for swarming; the other ten must be raised on large empty hives, the tops of which should be first taken off, and the joinings of the two hives secured with a little clay, which plan keeps the bees from swarming. In the month of September following, being the time I would recommend them to be burnt, each stock will seldom be found to have produced less than fifty pounds weight, provided it has been a kind season.

The prime swarms from the other stocks I would recommend to be put into three-peck hives, at least; for when they swarm so early, they are very likely to swarm again in a few weeks, which should always be prevented: and all the after swarms should be united, two or three into one; for the great advantage arises from the large quantity of bees being kept together, since by that mode ten stocks will generally yield fifteen good ones. But the greatest check to the cultivation of bees happens from inclement seasons: I have experienced some summers, when it has rained almost all the months of June and July, that not above one prime swarm in ten have been able to get a sufficiency: this is really distressing, and on these occasions I have seen the stocks of villagers wholly swept off.

This is another reason why double hives are so necessary; for, besides the great profit arising from them in fine seasons, it would prevent the decrease of stocks, which must unavoidably happen in bad seasons. In the most unkindly summers, they are sure to get enough to support them through the winter: whenever it happens so, they should stand till winter; and in a frosty day the clay should be removed, and a wire drawn between the hives, to separate them; for by this time they will all be in the upper hive; and these stocks should be reserved for swarming the following summer.

From a review of the above experiments, the reasons are obvious why people are so frequently disappointed in the management of bees, especially in the modern way; but, on the other hand, it shows what a surprising state of cultivation they might be carried to; and supposing they could be brought to a state of cultivation, that ten poor families in a village could keep twenty old stocks, besides their own profit, it might become a national concern. Great pains have been taken, and still greater encouragement offered, for a plan to preserve the lives of these useful and sagacious insects, which may be done by the intelligent, but cannot be expected from the cottager.

My stock consists of forty hives and boxes. The method I pursue in the management of bees is, to reserve part of my stocks for working; for, by giving them room, they seldom swarm: and I always work them upwards, for by that means the queen is kept in the under hive or box, and the honey so collected is of the purest quality.

But it is no easy thing to make them ascend, to work through holes or bars so recommended by authors, as I have frequently known them swarm before so doing. My way is: if it is a hive, I take a piece out of the top, with a knife and chisel, ten inches diameter; thus, by laying a large surface of their comb bare, I am never disappointed.

But they will be induced to rise sooner, by placing a piece of empty comb, so as to reach from their own to the top of the box or glass globe that is intended to be used; whenever it so happens, in wet summers, that each stock cannot get more than thirty pounds of honey, I always use Mr. Thorley's method, with the fungus*; and I cannot help being surprised that this simple method should not be commonly used to save the lives of these useful insects.

I am, sir, your very humble servant,

To SAMUEL MORE, *Esq. Sec.* GEORGE HUBBARD.

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* His book directs you to put it into a paper, pressing it down close, and immediately to put it into a slow oven for a night; but I have always found it, when thus prepared, to burn with great difficulty; whereas, if it is gathered in the early state, and hung up a week to dry by degrees, and then put into a slow oven, it burns remarkably well.

Bury, October 29, 1790.

This is to certify that Mr. George Hubbard, surgeon and apothecary, of Bury St. Edmunds, in the county of Suffolk, had in his possession, this present spring, 1790, thirty hives of bees; and by the month of May, this present year, has increased his stock to forty hives; and being desirous of sending an account of the management of his bees to the Society for the Encouragement of Arts, Manufactures, and Commerce, we, the undersigned, have subscribed this certificate.

T. H. CULLUM.
W. MATHEW.

Bury, Dec. 15, 1790.

Sir Thomas Cullum's respectful compliments to the committee of agriculture; and according to their request, signified by Mr. More, their secretary, he acquaints them, that he signed Mr. George Hubbard's certificate, certifying the number of hives of bees he had in his possession.

To SAMUEL MORE, *Esq. Sec.*

To the Society for the Encouragement of Arts, Manufactures, and Commerce.

Among the premiums for 1790, class 108, one is proposed for the most satisfactory account of the managing and preserving of bees, to the best advantage for collecting honey.

If gentlemen would but ornament their gardens with so noble a piece of furniture as an apiary, properly situated and carefully managed, they might be furnished with the valuable article of honey without adulteration, and also wholesome mead, little inferior to foreign wine.

Give me leave, gentlemen, to lay before you the method of managing my own bees, of which many ladies and gentlemen have been eye-witnesses, and have been served by me with as good honey as any in England.

In April, 1789, I had twenty-one stocks of bees, all in good condition, and wanting no feeding: the spring being friendly, they began to swarm in the middle of May, and continued till the latter end of June; and at that time I had about fifty swarms, notwithstanding I endeavoured to prevent such an increase, by glassing them; but many of the stocks swarmed before the glasses or small hives were full, for the mothers of all the stocks bred a prodigious quantity of working bees, which was the reason of their swarming so many times. What I call a mother, most writers on bees call a queen; but I am clear that she is the mother of the whole empire or stock, and suffers none of the royal seed to live, except what are intended to go forth with the young swarm, and a sufficient quantity of drones, which are the males, and sit upon the eggs as the mother lays them in the cells prepared for that purpose, while the working bees continue their labour in gathering honey and wax. I have often seen the drones sit in a formal manner over the combs, where the brood is hatching, while the other bees were very busy at work.

What I mean by a stock of bees, is an united company, consisting of three sorts, viz. a mother, a great number of working bees, and some drones; and they are congregated within themselves, by a strict union, and defend their hive or box from any molestation; for the working bees would instantly resent an injury with the fury of their stings.

My own hives are made in the following manner: nine inches deep, and fourteen diameter, containing each about five Winchester gallons, with a flat top made of well-seasoned deal, an inch thick, four holes at the top, one exactly over the mouth of the hive, the other three in a right angle; viz. Take an inch centre-bit, make three holes as near as possible, so that you have but a small partition of wood between them; let them be made smooth and neat; then take a circular piece of half-inch board, nail it over those holes which are made in the hive, and let them be made to fit so close that no moth can get among the young bees; so that when a swarm is put in one of these hives in May, or the beginning of June, and begins to fill the hive with combs, brood, &c., which you may perceive by means of small pieces of glass, three inches square, put in the back of the hive, to observe their operations, and the bees have filled their hive, and appear very busy at the mouth, open gently the hole on the top next the mouth, or rather right over the mouth, and place a proper glass over the hole, with proper sticks placed in the glass for the bees to hang their work upon, otherwise they would be a long time filling their glass, which if they kindly take to they will fill in twelve or fourteen days.

But if your stock increases, and perhaps lies out at the mouth of the hive, you must open a second hole at the top, and then a third, and so on to the fourth, if the bees increase, and continue to lie out at the mouth; and yet for all this many of my hives have swarmed, and left their glasses, &c., half full of honey.

Here give me leave to observe, that nature steps in to preserve the bees, when all other efforts are ineffectual. The bees have swarmed, settled on a bush, or about a tree, where there is no hope of their living without being hived, as they have left a good home, well stored with honey, and settled where there is none, and where they cannot make any. This has been the case last summer, for the mothers of the bees, through the kindliness of the season, have bred great quantities, so that we had a great many poor stocks that wanted feeding in the months of October and April.

(*To be continued.*)

LIST OF PATENTS FOR NEW INVENTIONS,

Which have passed the Great Seal since Nov. 6, 1827.

To James Smethurst, of New Bond-street, in the county of Middlesex, lamp manufacturer; for an improvement or improvements upon lamps. Dated Nov. 6, 1827.—To be specified in two months.

To Frederick Foveaux Weiss, of the Strand, in the city of Westminster and the county of Middlesex, surgeon's instrument maker; for certain improvements in the construction of spurs. Dated Nov. 6, 1827.—In two months.

To James White, of Paradise-street, Lambeth, in the county of Surrey, engineer; for a machine or apparatus for filtering, which he denominates an artificial spring. Dated Nov. 8, 1827. —In two months.

To John Platt, of Salford, near Manchester, in the county of Lancaster, fustian dresser; who, by certain communications made to him by a foreigner residing abroad, is in possession of certain improvements in machinery, for combing wool and other fibrous materials. Dated Nov. 10, 1827.—In six months.

To William Collar, of Salford, in the county of Lancaster, fustian shearer; who, in consequence of certain communications made to him by a foreigner residing abroad, is in possession of certain improvements in the power-loom for weaving. Dated Nov. 10, 1827.—In six months.

To John Walker, of Weymouth-street, in the parish of St. Marylebone, in the county of Middlesex, esq.; for an improved castor for furniture. Dated Nov. 17, 1827.—In two months.

To Henry Pinkus, of the city of Philadelphia, state of Pennsylvania, in the United States of America, gent.; for an improved method of purifying carburetted hydrogen gas for the purpose of illumination. Dated Nov. 17, 1827.—In six months.

To Samuel Sevill, of Brownshill, in the parish of Disley, in the county of Gloucester, clothier; for certain improvements applicable to raising the pile, and dressing woollen and other cloths. Dated Nov. 20, 1827. In six months,

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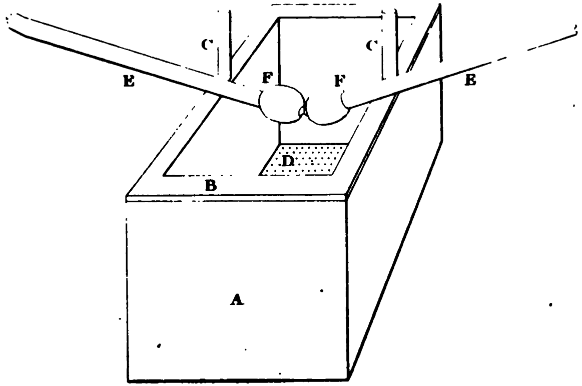

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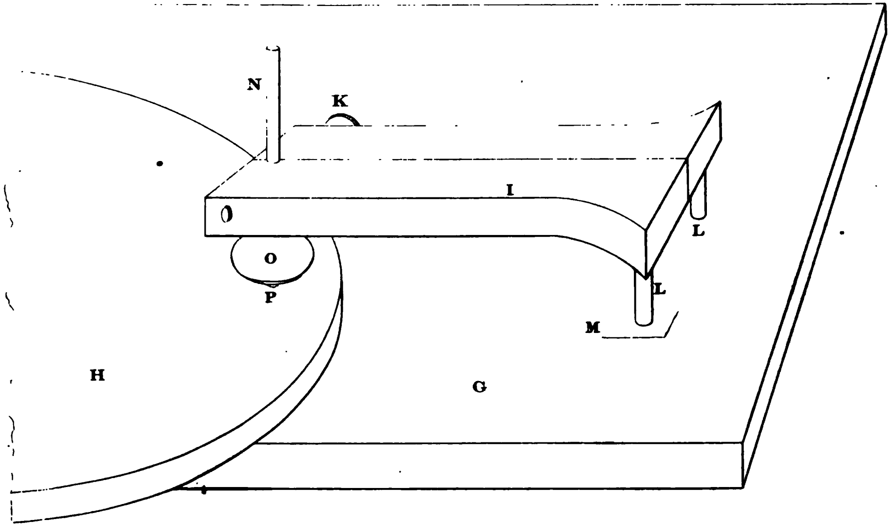

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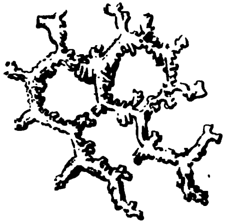

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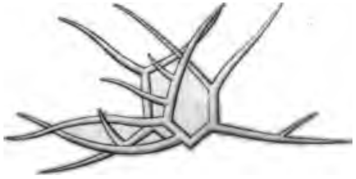

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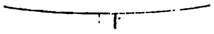

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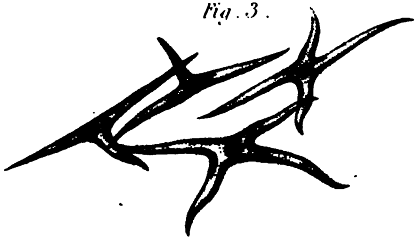

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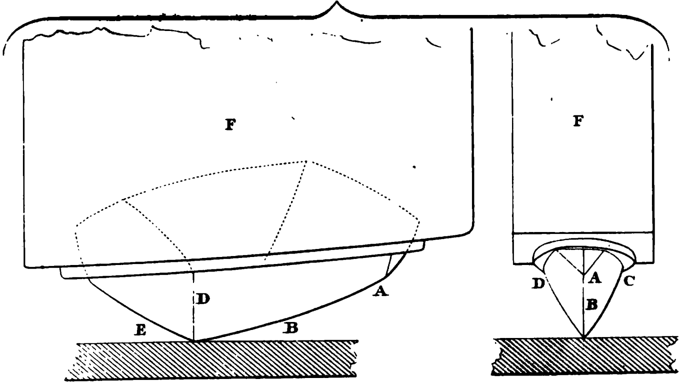

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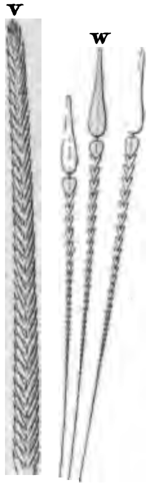

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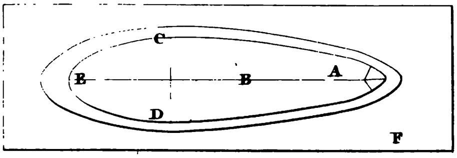

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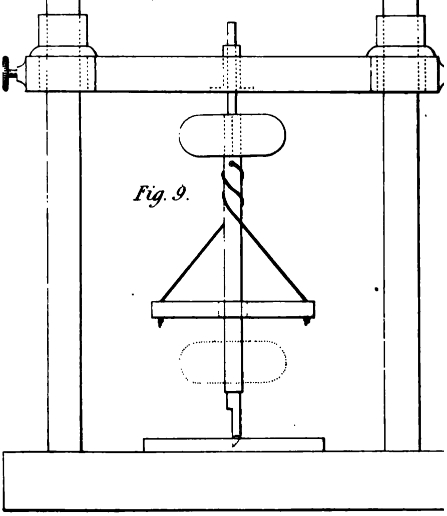
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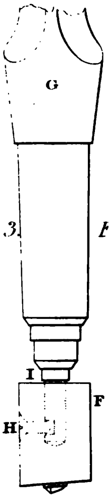

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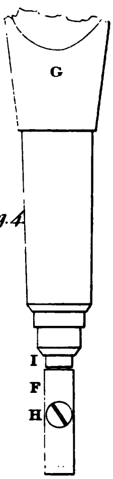

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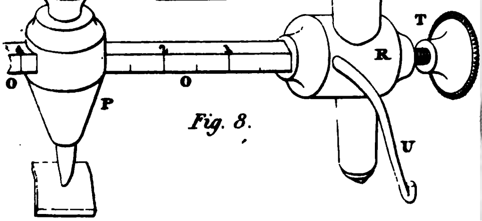

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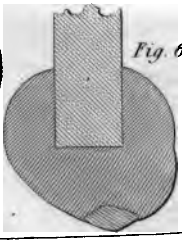
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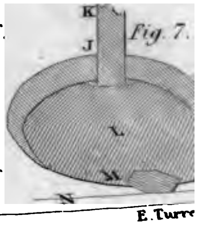
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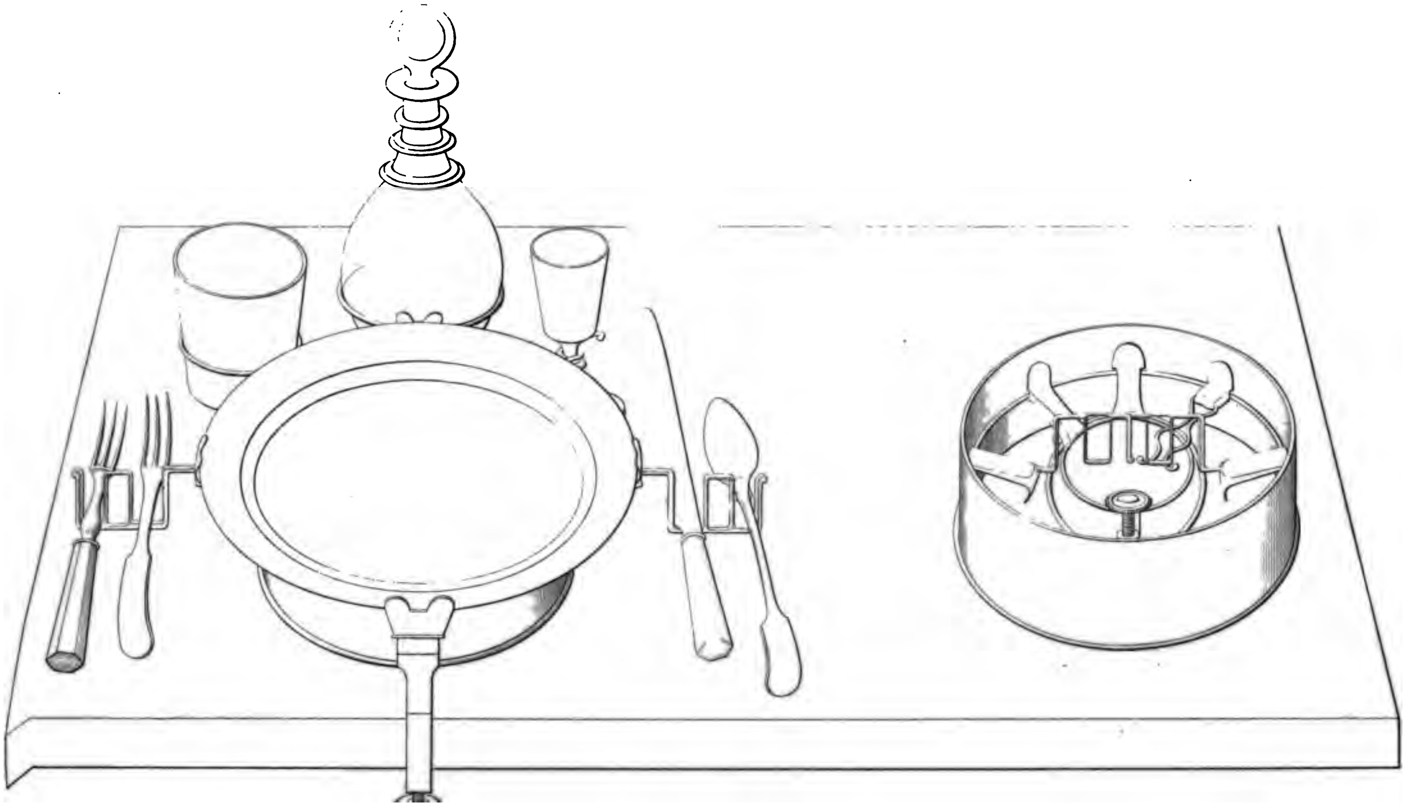

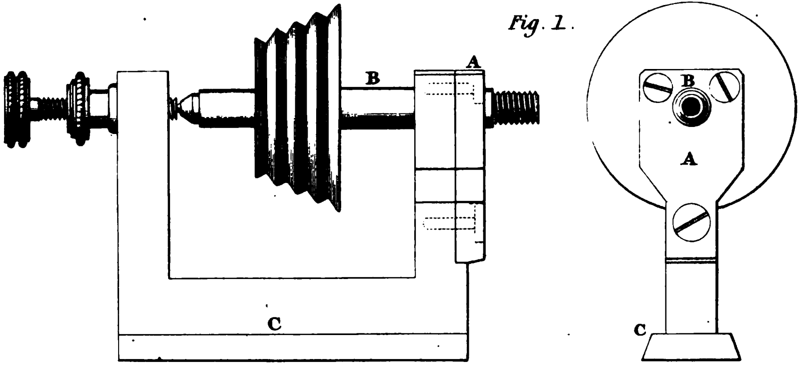

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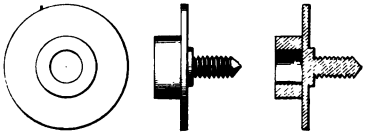

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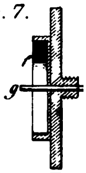

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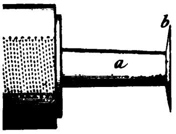

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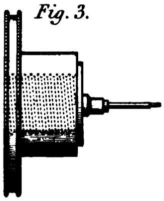

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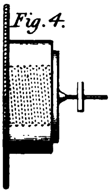

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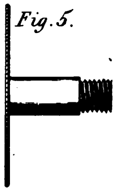

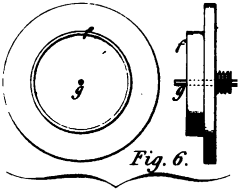

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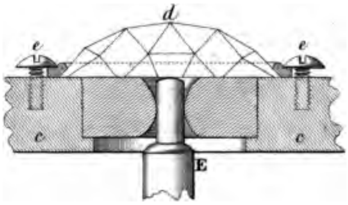

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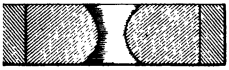

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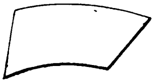

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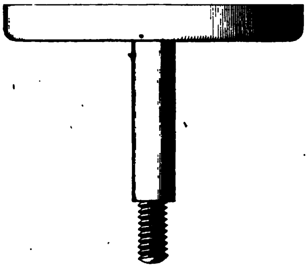

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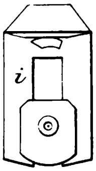

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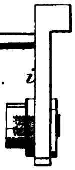

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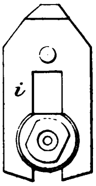

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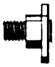

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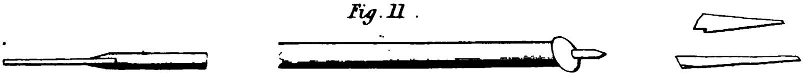

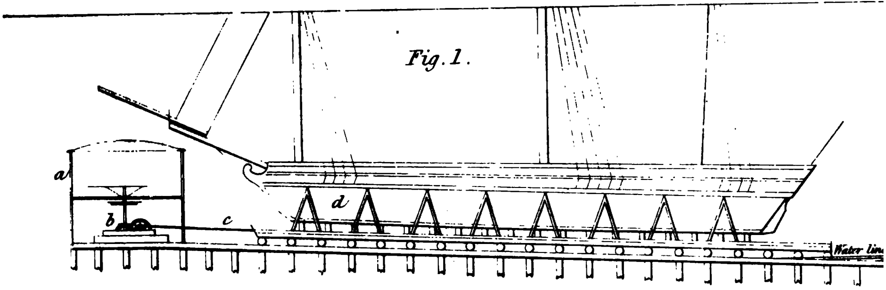
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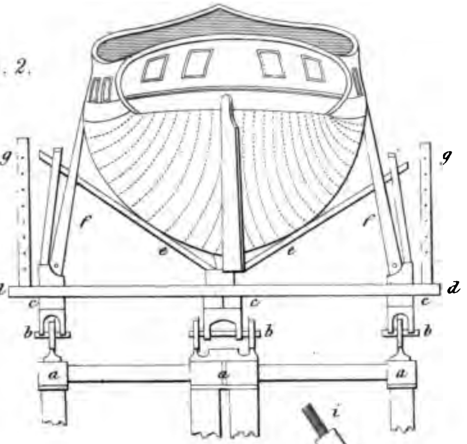
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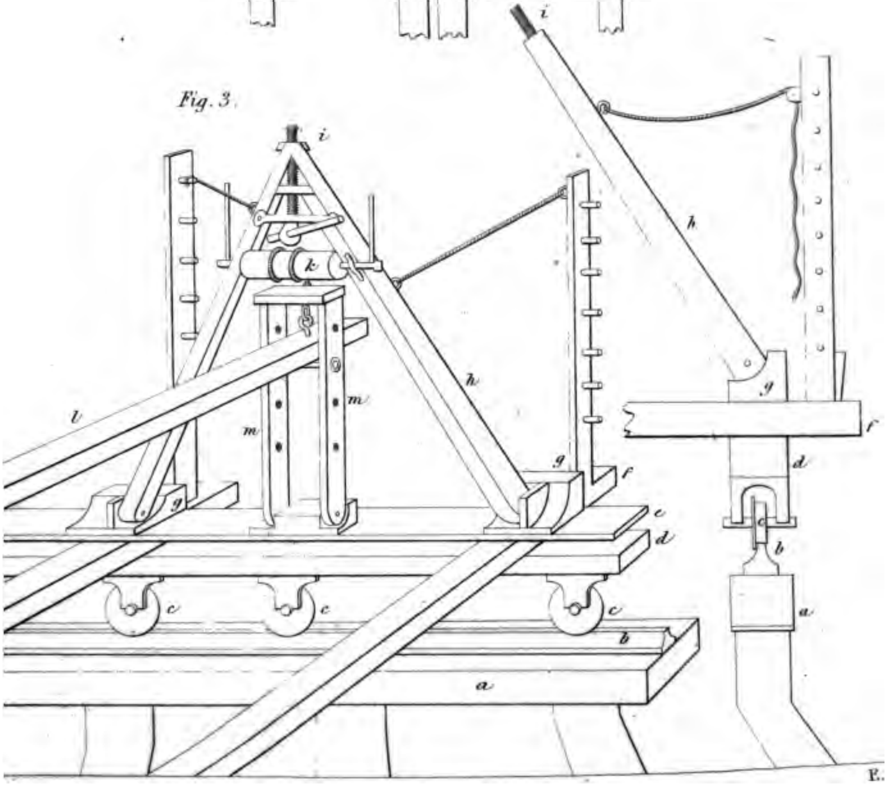
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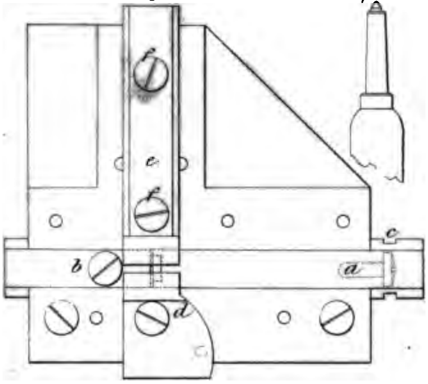

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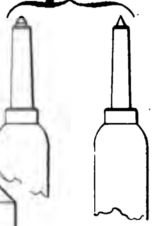

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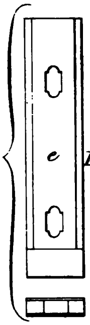

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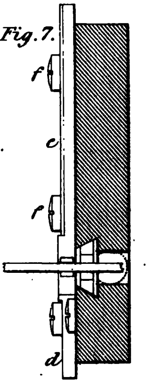

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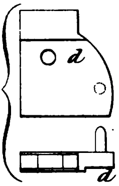

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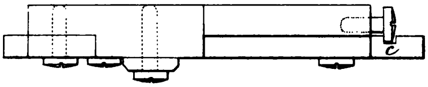

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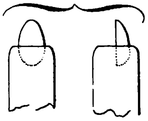

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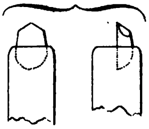

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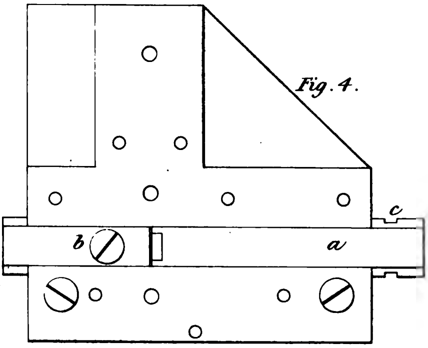

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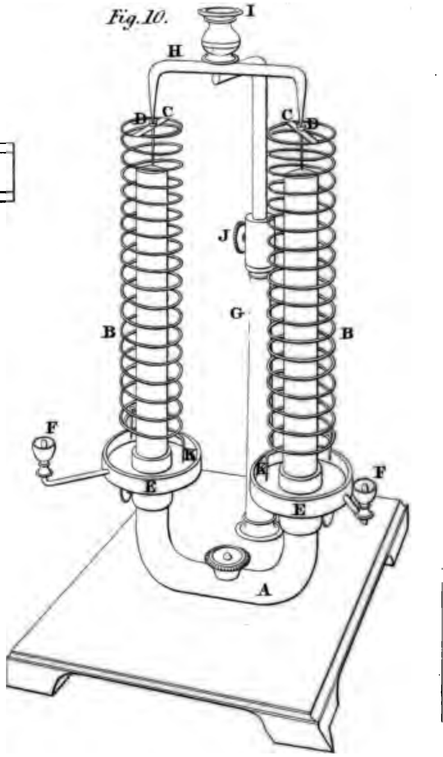

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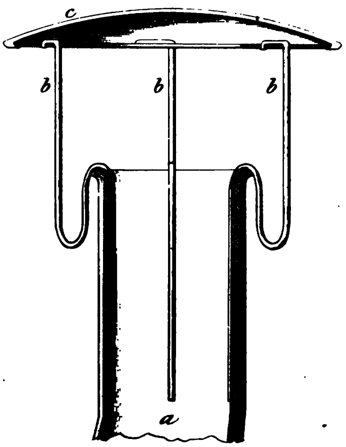

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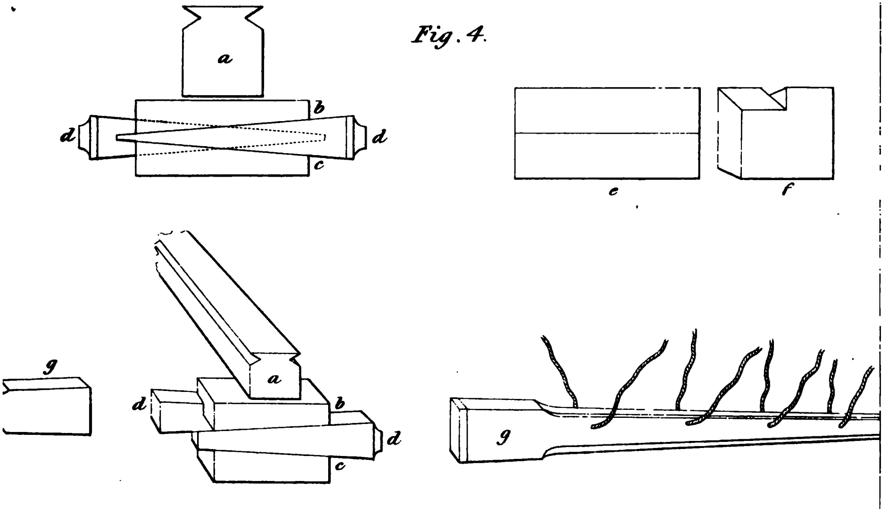

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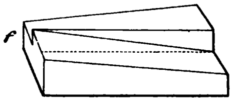

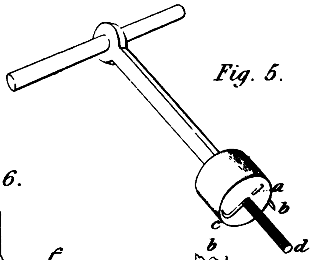

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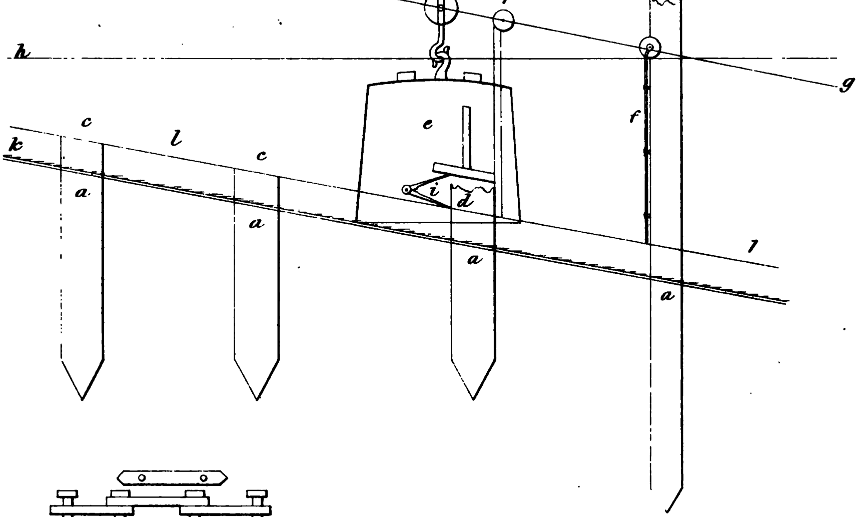

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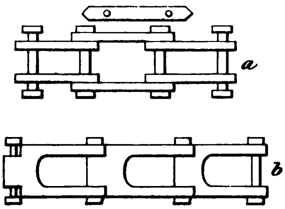

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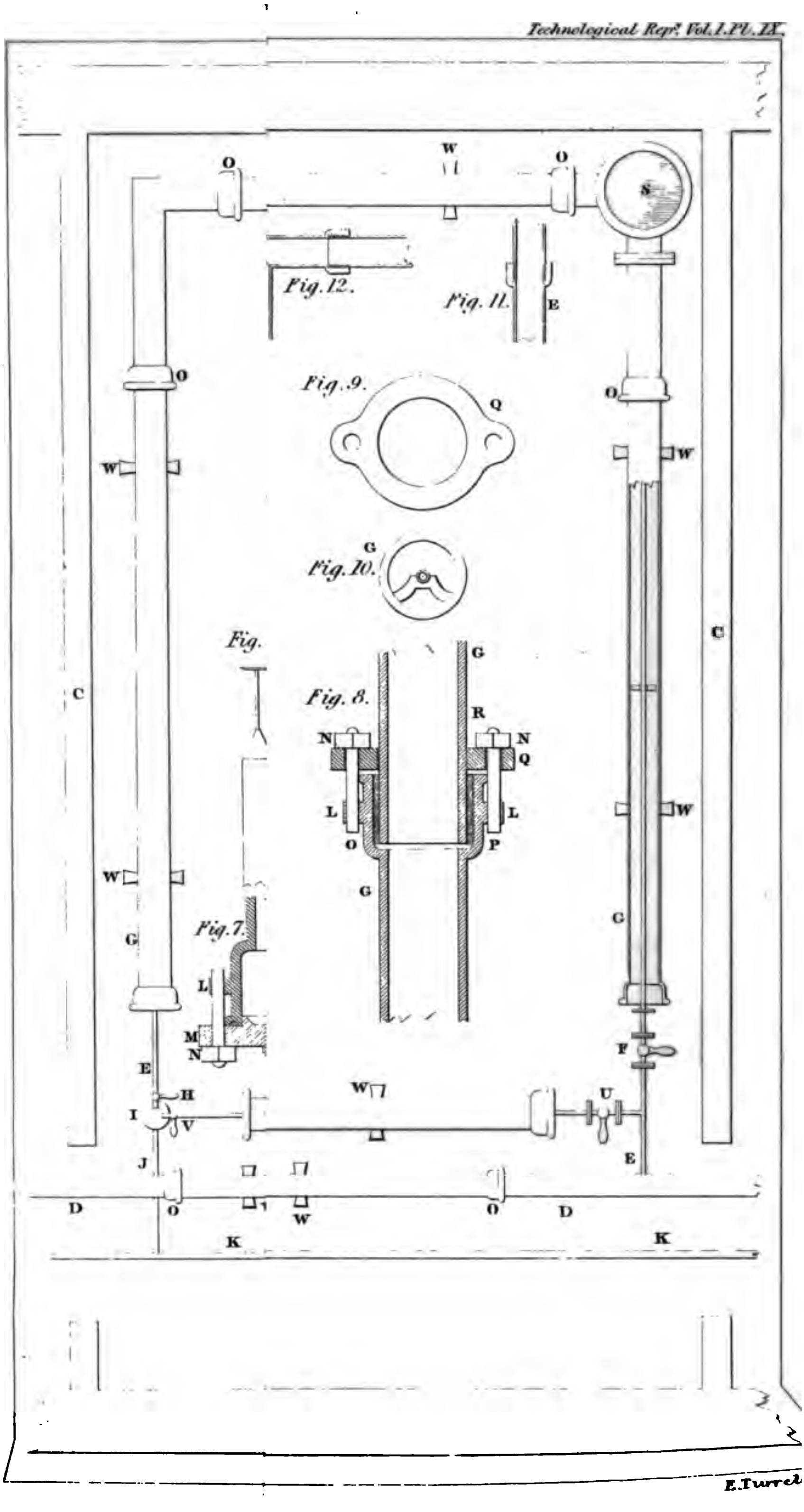

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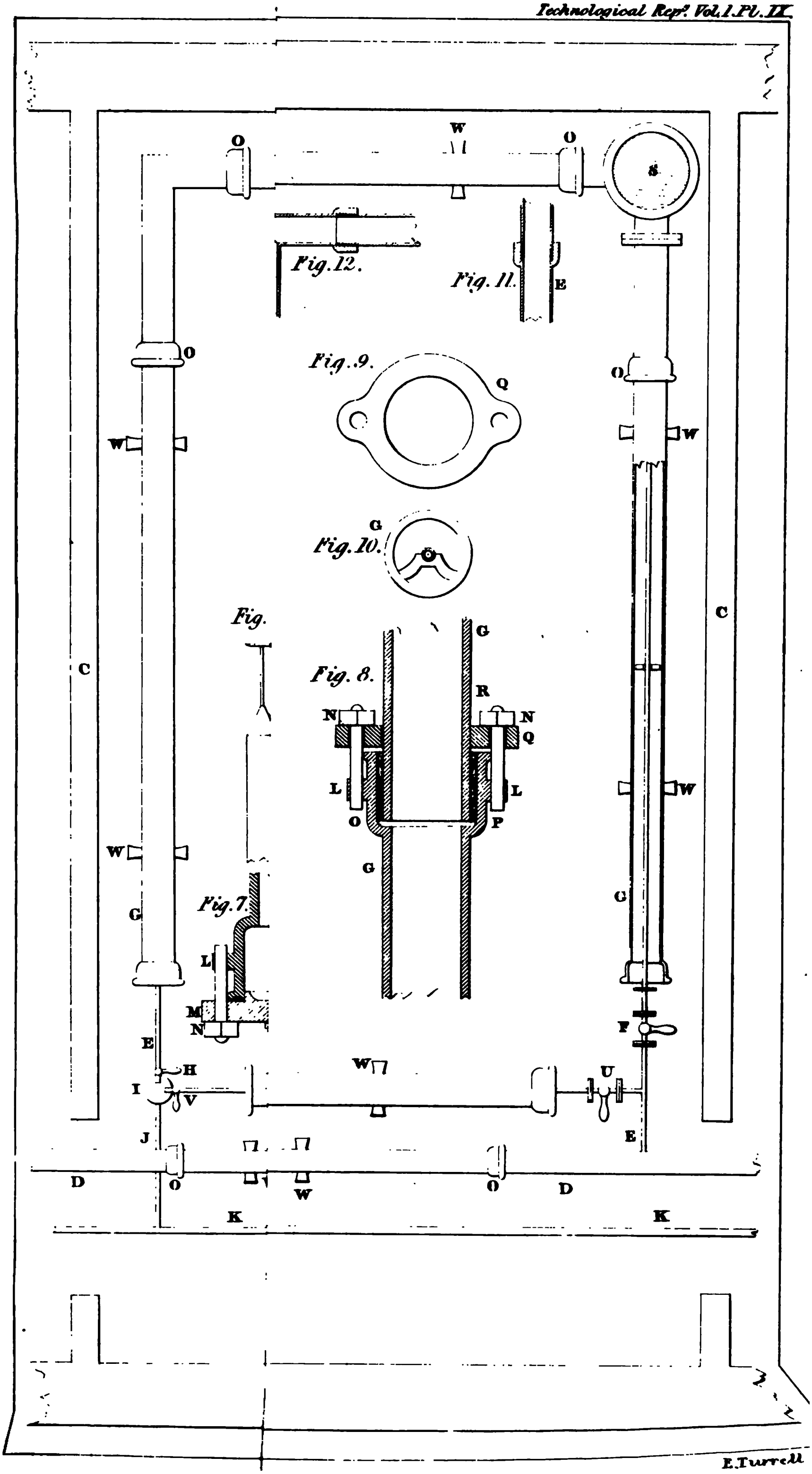
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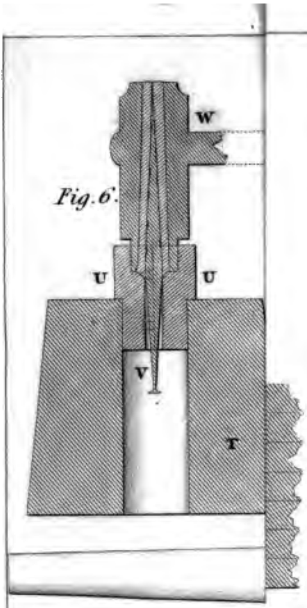
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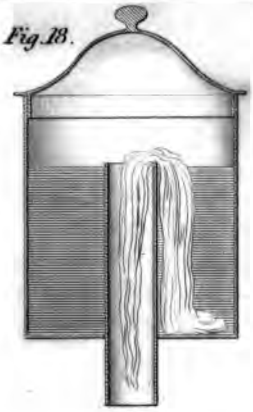
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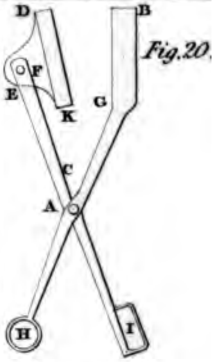
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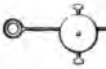
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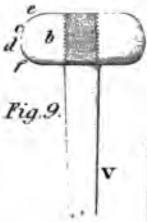
Fig. 9.

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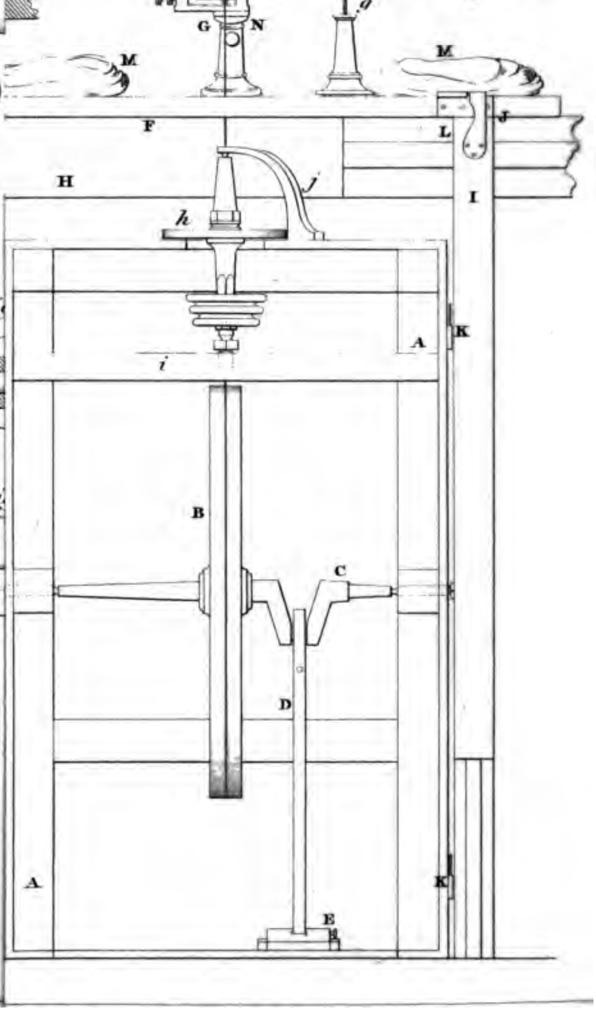

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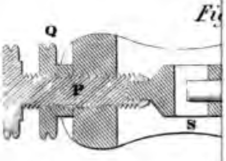

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